

**80/405/CDV****COMMITTEE DRAFT FOR VOTE (CDV)
PROJET DE COMITÉ POUR VOTE (CDV)**

Project number Numéro de projet		IEC 62287 Ed.1	
IEC/TC or SC: TC 80 CEI/CE ou SC:	Date of circulation Date de diffusion 2005-03-11	Closing date for voting (Voting mandatory for P-members) Date de clôture du vote (Vote obligatoire pour les membres (P)) 2005-08-12	
Titre du CE/SC:		TC/SC Title: Maritime navigation and radiocommunication equipment and systems	
Secretary: UK Secrétaire:			
Also of interest to the following committees Intéresse également les comités suivants		Supersedes document Remplace le document 80/287/NP - 80/304/RVN	
Functions concerned Fonctions concernées <input type="checkbox"/> Safety <input type="checkbox"/> EMC <input type="checkbox"/> Environment <input type="checkbox"/> Quality assurance Sécurité CEM Environnement Assurance qualité			

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Title : Maritime navigation and radiocommunication equipment and systems - Class B shipborne equipment of the Automatic Identification System (AIS) using CSTDMA techniques - Operational and performance requirements, methods of test and required test results

Introductory note IEC 61993-2 gives operational and performance requirements for Class A shipborne equipment of the AIS. Class A is required to meet the mandatory carriage requirements of the International Convention for the Safety of Life at Sea (SOLAS) and uses SOTDMA techniques. This standard gives requirements for an AIS usable by ships not subject to the SOLAS Convention. Class B uses CSTDMA techniques which are designed to be compatible with Class A equipment.

ATTENTION	ATTENTION
CDV soumis en parallèle au vote (CEI) et à l'enquête (CENELEC)	Parallel IEC CDV/CENELEC Enquiry

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MARITIME NAVIGATION AND RADIOCOMMUNICATION
EQUIPMENT AND SYSTEMS****Class B shipborne equipment of the
Automatic Identification System (AIS) using CSTDMA techniques**

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INTRODUCTION

In the ITU Radiocommunications Sector Recommendation ITU-R M.1371 "Technical characteristics for a universal shipborne Automatic Identification System (AIS) using TDMA (Self-Organising Time Division Multiple Access) in the VHF maritime mobile band", provision is made for a Class B AIS for use on craft not covered by a mandatory carriage requirement under SOLAS Chapter V, Regulation 19. This Standard sets out the requirements, method of test and required test results for such a Class B AIS.

The International Maritime Organisation (IMO), in its Resolutions MSC.140(76), Recognised that the radio channels used by AIS, particularly AIS 1 (161,975 MHz) and AIS 2 (162,025 MHz), are regarded as an AIS network, and any disruption to those channels by any one AIS device could affect the operation of all AIS devices on that network. IMO also recognised that Administrations should take steps necessary to ensure the integrity of the radio channels used for AIS in their waters.

IEC Technical Committee 80 (TC80) allocated a new work item 80/287 to Working Group 8a (WG8a), tasking them with producing a Test Standard for Class B AIS equipment. During the development of this Test Standard, Administrations expressed concern that large numbers of Class B AIS equipped vessels could have a detrimental effect on the safe operation of the AIS network by Class A vessels, Base Stations and AIS on Aids to Navigation (AtoN AIS). As a result, new network access technology was developed, which allows large numbers of Class B fitted vessels to coexist with Class A with a negligible detrimental effect on AIS network.

The new technology, hereafter referred to as "Carrier-Sense TDMA (CSTDMA)", requires that the Class B"CS" AIS listens to the AIS network to determine if the network is free of activity and, only if the network is free, can it transmit its information. The Class B AIS is also required to listen for reservation messages and comply with these reservations. This polite operation ensures that a Class B AIS will not interfere with Class A, Base Station or AtoN AIS operations. Extensive computer models simulation and practical laboratory testing and sea trials were undertaken to validate CSTDMA during its development.

WG8a recognised that the primary function of a Class B AIS is for fitted vessels to be visible and participate in the AIS network. CSTDMA was designed to fulfil these requirements.

ITU-R M.1371-1 will be updated to reflect the requirements of this new CSTDMA access scheme.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS

Class B shipborne equipment of the Automatic Identification System (AIS) using CSTDMA techniques

1 Scope

This International Standard specifies the minimum safe operational & performance requirements, methods of testing and required test results for class B shipborne AIS equipment using Carrier-Sense TDMA (CSTDMA) techniques. This Standard takes into account other associated IEC International Standards and existing National Standards, as applicable.

It is applicable for AIS equipment used on craft that are not covered by a mandatory carriage requirement of AIS under SOLAS Chapter V.

An AIS station intended to operate in receive-only mode shall not be considered a Class B shipborne mobile AIS station.

2 Normative References

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to apply. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60945 Ed. 4.0 Maritime navigation and radiocommunication equipment and systems - General requirements - Methods of testing and required test results.

IEC 61108-1 Ed.2.0 Global navigation satellite systems (GNSS) - Part 1: Global positioning system (GPS) - Receiver equipment - Performance standards, methods of testing and required test results.

IEC future publication 61108-4 Shipborne DGPS and DGLONASS maritime radio beacon receiver equipment.

IEC 61162-1 Ed. 1.0 Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 1: Single talker and multiple listeners.

IEC 61162-2 Ed. 1.0 Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 2: Single talker and multiple listeners, high-speed transmission.

ISO 10133:2000 Small craft – electrical systems – extra low voltage d.c. installations

ISO/IEC 3309: 1993 Information technology -- Telecommunications and information exchange between systems -- High-level data link control (HDLC) procedures -- Frame structure.

IMO Resolution A.694(17): General requirements for shipborne radio equipment forming part of the Global Maritime Distress and Safety System (GMDSS) and for electronic navigational aids.

IMO MSC.140(76) Recommendation for the protection of the AIS VHF data link

ITU-R Recommendation M.489-2 Technical characteristics of VHF radiotelephone equipment operating in the maritime mobile service in channels spaced by 25 kHz

ITU-R Recommendation M.825-3 (10/98) Characteristics of a transponder system using digital selective calling techniques for use with vessel traffic services and ship-to-ship identification.

ITU-R Recommendation M.1084-4 (12/00) Interim solutions for improved efficiency in the use of the band 156-174 MHz by stations in the maritime mobile service.

Note: ITU-R M.1371-1 references ITU-R M.1084-3, Annex 3. A Draft Revision of Recommendation ITU-R M.1084-3, consequentially leading to ITU-R M.1084-4, has been approved in parallel to the approval of ITU-R M.1371-1.

ITU-R Recommendation M.1371-1 (12/00) Technical characteristics for a universal shipborne automatic identification system using time division multiple access in the VHF maritime mobile band.

3 Abbreviations

AIS	Automatic Identification System
BER	Bit Error Rate
BT	Bandwidth Time product
COG	Course over ground
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
CS	Carrier Sense
DGNSS	Differential Global Navigation Satellite Service
DLS	Data Link Service
DSC	Digital Selective Calling
ECDIS	Electronic chart display and information system
EPFS	Electronic position fixing system
ETA	Estimated Time of Arrival
EUT	Equipment under test
FCS	Frame Check sequence
FM	Frequency Modulation
GMSK	Gaussian Minimum Shift Keying
GNSS	Global Navigation Satellite Service
HDG	Heading
HDLC	High level Data Link Control
HSC	High speed craft
IHO	International Hydrographic Office
IMO	International Maritime Organisation
LME	Link Management Entity
LR	Long Range
MAC	Medium access control
MMSI	Maritime Mobile Service Identity
NM	Nautical Miles (refer to ISO 19018)

NRZI	Non Return to Zero Inverted
NUC	Not under command
OSI	Open System Interconnection model
PER	Packet Error Rate
PI	Presentation Interface
PRS	Pseudo Random Sequence
RAIM	Receiver autonomous integrity monitoring
Rx	Receive
SINAD	Signal Interference Noise and Distortion ratio
SOG	Speed over ground
TDMA	Time Division Multiple Access
Tx	Transmit
UTC	Universal Time Co-ordinated
VDL	VHF Data Link
VDM	Serial output message containing VDL information (IEC 61162-1)
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio
VTs	Vessel Traffic Services

Note: Abbreviations related to IEC 61162 series are not included in the above list. For their meaning refer to that International Standard.

4 General requirements

4.1 (A3/1) General

4.1.1 Capabilities of the Class B“CS” AIS

The Class B“CS” AIS shall improve the safety of navigation by assisting in the efficient navigation of ships and small craft, protection of the environment, and operation of Vessel Traffic Services (VTS).

The Class B“CS” AIS shall be capable of providing information from the craft, automatically, continuously and with the required accuracy and update rate

- in a ship-to-ship mode for collision avoidance;
- as a means for littoral States to obtain information about the craft; and
- as a VTS tool, i.e. ship-to-shore (traffic management).

The Class B“CS” AIS station shall be inter-operable and compatible with Class A or other Class B shipborne mobile AIS stations or any other AIS station operating on the AIS VHF Data Link. In particular, Class B“CS” AIS stations shall receive other stations, shall be received by other stations and shall not degrade the integrity of the AIS VHF Data Link.

The Class B“CS” AIS shall only transmit if it has verified that the time period intended for transmission does not interfere with transmissions made by equipment complying with IEC 61993-2, IEC 62320-1 or IEC 62320-2. Transmissions of the Class B“CS” AIS shall not exceed one nominal time period (except when responding to a Base station with msg19).

4.1.2 Quality assurance

Manufacturers shall have a quality control system ¹ audited by a competent authority to ensure continuous compliance with the requirements of this standard. Alternatively, the manufacturer may use final product verification procedures where a competent authority verifies compliance with the requirements of this standard before the product is put to the market.

4.1.3 Safety of operation

It shall not be possible for the operator to augment, amend or erase any program software in the equipment required for operation in accordance with the equipment standard. Data used during operation and stored in the system shall be protected in such a way, that necessary modifications and amendments by the user cannot endanger its integrity and correctness.

4.1.4 Additional features

Where equipment provides a facility that is additional to the minimum requirements of this standard, the operation and, as far, as is reasonably practicable, the malfunction of such additional facility shall not degrade the performance of the equipment.

4.1.5 (A3/2) Modes of Operation

The system shall be capable of operating in a number of modes as described below subject to the transmission of messages by a competent authority. It shall not retransmit received messages.

4.1.5.1 Autonomous and continuous mode

An "autonomous and continuous" mode for operation in all areas transmitting message 18 for scheduled position reporting and msg24 for static data.

The Class B"CS" AIS shall be able to receive and process messages at any time except during time periods of own transmission.

4.1.5.2 Assigned mode

An "assigned" mode for operation in an area subject to a competent authority responsible for traffic monitoring such that

- the reporting interval, silent mode and/or transceiver behaviour may be set remotely by that authority using group assignment by message 23 or
- time periods are reserved by message 20 (see 7.3.1.5).

4.1.5.3 Interrogation mode

A "polling" or controlled mode where the Class B"CS" AIS responds to interrogations for message 18 and 24 from a Class A AIS or a Base Station. A Base Station interrogation for message 19 specifying transmission offset shall also be answered². An interrogation overrides a silent period defined by message 23 (see 7.3.3.3.3).

A Class B"CS" AIS shall not interrogate other stations.

¹ ISO 9000 series, as applicable, meets this requirement.

² Note that because msg19 is a message occupying two time periods, this requires the reservation of the respective time periods by msg20 prior to interrogation.

4.2 Manuals

The manuals shall include:

- the type of external connectors if applicable
- the needed information for correct siting of the antennas
- the needed information for Compass safe distance

4.3 Marking and identification

Each unit of the equipment shall be marked externally with the following information which, where practicable, shall be clearly visible in the normal installed position:

- identification of the manufacturer;
- equipment type number or model identification; and
- Serial number of the unit.
- Power supply requirements
- Compass safe distance

Alternatively, the marking may be presented on a display at equipment start-up.

The version of software shall be either marked or displayed on command on the equipment.

When the marking and the title and version of the software are displayed only on the display, such information shall also be included in the equipment manual.

5 Environmental, power supply, interference and safety requirements

In addition to the specific requirements of this standard, the B“CS” AIS shall fulfil the following general requirements as detailed in IEC 60945:

- Inter-unit connection (other interfaces than IEC 61162 are allowed; see 6.7.3)
- Power supply
- Extreme power supply
- Excessive conditions
- Power supply short-term variation and power supply failure
- The B“CS” AIS shall not enter an undefined or unstable state in case of undervoltage
- Durability and resistance to environmental conditions
- Interference
- Electromagnetic compatibility
- Compass safe distance
- Safety precautions
- Protection against accidental access to dangerous voltages
- Electromagnetic radiofrequency radiation
- X-radiation

The manufacturer shall declare the category of the equipment as follows:

- a) portable
- b) protected from the weather
- c) exposed to the weather
- d) submerged or in continuous contact with sea water.

6 Performance requirements

6.1 Composition

The B“CS” AIS shall comprise:

- A communication processor, capable of operating in a part of the VHF Maritime Mobile Service band, in support of short range (VHF) applications.
- At least one transmitter and three receiving processes, two for TDMA and one for DSC on channel 70. The DSC process may use the receiving resources on a time-share basis as described in 7.2.1.6. Outside the DSC receiving periods the two TDMA receiving processes shall work independently and simultaneously on AIS channels A and B.³
- A means for automatic channel switching in the maritime mobile band (by message 22 and DSC; message 22 shall have precedence). Manual channel switching shall not be provided.
- An internal GNSS position sensor, which provides a resolution of one ten thousandth of a minute of arc and uses the WGS-84 datum (see 6.3 internal GNSS receiver).

6.2 Operating frequency channels

The Class B“CS” AIS shall operate at least on the frequency channels with 25 kHz bandwidth in the range from 161,500 MHz to 162,025 MHz of the ITU Radio Regulations appendix 18 and in accordance with Recommendation ITU-R M.1084, annex 4. The DSC receiving process where provided shall be tuned to Channel 70.

The Class B“CS” AIS shall automatically revert to receive-only mode on the channels AIS1 and AIS2 when commanded to frequency channels outside its operating range and/or bandwidth.

6.3 Internal GNSS Receiver for position reporting

The Class B“CS” AIS shall have an internal GNSS receiver as source for position, COG, SOG.

The internal GNSS receiver shall meet the following requirements of IEC 61108-1:

- position accuracy; static and dynamic (5sec),
- COG / SOG accuracy,
- position update (5sec),
- Interference susceptibility and
- status indications (RAIM optional)

The internal GNSS receiver may be capable of being differentially corrected, e.g. by evaluation of message 17.

³ In some regions, the competent authority may not require DSC functionality

An input port for an external GNSS receiver may be provided. The data of an external GNSS receiver shall only be used if

- The manufacturer shall state, in the installation handbook, that this equipment shall only be connected to a position source that is using WGS84 datum,
- A valid RAIM sentence (GBS) is received and indicates an expected error of less than 10m in LAT or LON,
- The external position is within 26m of the internal position and
- The input format complies with IEC61162-1 including mode indicator and checksum.

6.4 Identification

For the purpose of ship and message identification, the appropriate Maritime Mobile Service Identity (MMSI) number shall be used. The unit shall only transmit if an MMSI is programmed.

6.5 AIS Information

6.5.1 Information content

The information provided by the Class B“CS” AIS shall include (see message 18; ITU-R M.1371-1 table 31):

6.5.1.1 Static

- Identification (MMSI)
- Name of ship
- Type of ship
- Vendor ID (optional)
- Call sign
- Dimensions of ship and reference for position

The default value for Type of ship shall be 37 (pleasure craft).

6.5.1.2 Dynamic

- Ship's position with accuracy indication and integrity status
- Time in UTC ⁴
- Course over ground (COG)
- Speed over ground (SOG)
- True heading (optional)

6.5.1.3 Configuration information

The following information about configuration and options active in the specific unit shall be provided:

- AIS Class B“CS” unit
- Availability of Minimum keyboard / display facility
- Availability of DSC Ch.70 receiver
- Ability to operate in the whole marine band or 525kHz band
- Ability to process channel management message 22

⁴ Date to be established by receiving equipment

6.5.1.4 Short safety-related messages

- Short safety-related messages, if used, shall be in compliance with ITU-R M.1371 and shall use pre-configured contents.

It shall not be possible for the user to alter the pre-configured contents.

6.5.2 Information reporting intervals

The Class B"CS" AIS shall transmit position reports (18) in reporting intervals of

- 30sec if SOG > 2 knots
- 3 min if SOG ≤ 2 knots

provided that transmission time periods are available. A command received by message 23 shall override the reporting interval; a reporting interval of less than 5 sec is not required.

Static Data submessages 24A and 24B shall be transmitted every 6 min in addition to and independent of the position report (see 7.4.1). Message 24B shall be transmitted within 1 minute following message 24A.

6.5.3 Permissible initialisation period

The AIS shall start transmitting position reports within

- Cold start: 30 min
- Warm start: (if off for less than 1h) 5 min
- Short signal loss: (GNSS signal lost for less than 5 min) resume within 1 min

6.6 Alarms and indications, fall-back arrangements

6.6.1 Built in Integrity test

The AIS shall be equipped with built in integrity tests (BIIT). They shall run continuously or at appropriate intervals simultaneously with the standard functions of the equipment.

If any failure or malfunction is detected that will significantly reduce integrity or stop operation of the AIS, a visual indication shall be given (e.g. LED, see 6.7.1).

The AIS installation, when operating, shall not be damaged by the effects of open circuited or short circuited antenna terminals.

6.6.2 Transmitter shutdown procedure

An automatic transmitter shutdown shall be provided in the case that a transmitter does not discontinue its transmission within 1 sec of the end of its nominal transmission. This procedure shall be independent of the operating software.

6.6.3 Position sensor fallback conditions

Priorities and affected position report data (refer to ITU-R M.1371 A2/3.3.8.2.1) shall be as follows:

Table 1 Position sensor fallback conditions

Priority	Affected data in msg18 ⇒		position accuracy flag	Time Stamp	RAIM-Flag	Position
	Position Sensor status					Longitude / Latitude
1.	external DGNSS in use (corrected) 1		1 *	UTC-sec	1 / 0 *	Lat/Lon (external)
2.	internal DGNSS in use (corrected; msg17)2		1 *	UTC-sec	1 / 0 *	Lat/Lon (internal)
3.	internal DGNSS in use (corrected; e.g. beacon)3		1 *	UTC-sec	1 / 0 *	Lat/Lon (internal)
4.	external EPFS in use (uncorrected) 1		0 *	UTC-sec	1 / 0 *	Lat/Lon (external)
5.	internal GNSS in use (uncorrected)2		0 *	UTC-sec	1 / 0 *	Lat/Lon (internal)
6.	no sensor position in use	manual pos. input	N/A	61	N/A	Don't transmit
		dead reckoning pos.		62		Don't transmit
		no position		63		Don't transmit

* If RAIM available “1”; if not, default “0”

1 Applicable only if an input from an external GNSS receiver is provided (see 6.3) which may only be used if the conditions specified in 6.3 are fulfilled.

2 Applicable in all configurations (minimum requirement).

3 Applicable only if (optionally) an internal beacon receiver is provided.

If RAIM is available, the position accuracy flag shall be evaluated using following table:

Table 2 Use of accuracy (PA) flag

		PA flag	RAIM flag
uncorrected	No RAIM, GBS invalid	0	0
	GBS valid, expected error <5m	1	1
	GBS valid, expected error >5m	0	1
corrected	No RAIM, GBS invalid	0	0
	GBS valid, expected error <15m	1	1
	GBS valid, expected error >15m	0	1

If the internal GNSS sensor is inoperative, the unit shall not transmit scheduled messages 18 and 24 unless interrogated by a Base Station⁵.

The Class B“CS” AIS shall automatically select the position source with the highest priority available. If data availability changes, the CLASS B“CS” AIS shall maintain the position source for the next scheduled position report and automatically switch to the position source with the highest priority available afterwards. During this period, the latest valid position shall be used for reporting.

⁵ Note that in this case the synchronisation process will not take into account distance delays.

6.6.4 SOG / COG sensor fallback conditions

SOG/COG information shall be of the same source as position and follow the same fallback rules. This is to avoid transmission of information referenced to different points on the ship.

6.7 User interface

6.7.1 Indicators and display

The CLASS B“CS” AIS shall provide the following indicators:

- | | |
|-------------|---|
| Power: | Power on and fully operable (transmitting and receiving properly); |
| TX timeout: | if the unit has not transmitted a position report during the last two reporting intervals (nominal reporting interval can not be maintained for operational reason, e.g. message 23 quiet period, high VDL load); |
| Error: | detection of an error as a result of the BIIT. |

If a display for received messages is provided, it shall:

- Display received messages 14
- Not display messages addressed to other stations.

6.7.2 Static data input

Means shall be provided to input and verify the MMSI prior to use. It shall not be possible for the user to alter the MMSI once programmed.

6.7.3 External interfaces

To enable a user to access, select and display the information on a separate system, the CLASS B“CS” AIS may be provided with an interface. If implemented, the formats and protocol for this data stream shall be as defined by IEC 61162 series (electrical parameters as specified by manufacturer). If provided, this interface shall not output information addressed to other stations.

The CLASS B“CS” AIS may be provided with an interface to input sensor data. If provided, an input interface for position sensor data shall be compliant with IEC 61162 series.

7 Technical requirements

7.1 General

This clause covers layers 1 to 4 (Physical Layer, Link Layer, Network Layer, Transport Layer) of the Open System Interconnection (OSI) model.

Figure 1 illustrates the layer model of an AIS station (Physical Layer to Transport Layer) and the layers of the applications (Session Layer to Application Layer):

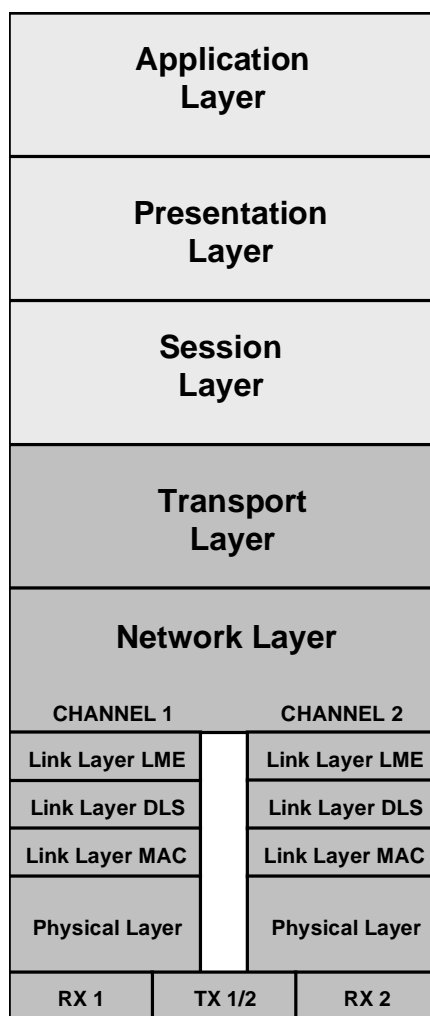


Figure 1 OSI layer model

7.2 Physical layer

The Physical layer is responsible for the transfer of a bit-stream from an originator to the data link.

7.2.1 Transceiver characteristics

General transceiver characteristics shall be as specified in Table 3.

Table 3 Transceiver characteristics

Symbol	Parameter name	value	tolerance
PH.RFR	Regional frequencies (range of frequencies within RR Appendix 18) ¹ (MHz) Full range 156,025 to 162,025 is also allowed. This capability will be reflected in message 18.	161,500 to 162,025	-
PH.CHS	Channel spacing (encoded according to RR Appendix 18 with footnotes) ¹ (kHz) Channel bandwidth	25	-
PH.AIS1	AIS 1 (default channel 1) (2087) ¹ (MHz)	161,975	±3 ppm
PH.AIS2	AIS 2 (default channel 2) (2088) ¹ (MHz)	162,025	±3 ppm
PH.BR	Bit rate (bit/s)	9 600	± 50 ppm
PH.TS	Training sequence (bits)	24	-
	GMSK transmitter BT-product	0,4	
	GMSK receiver BT-product	0,5	
	GMSK modulation index	0,5	
¹ See Recommendation ITU-R M.1084, Annex 4.			

7.2.1.1 Dual channel operation

The AIS shall be capable of operating on two parallel channels in accordance with 7.4.1. Two separate TDMA receive channels or processes shall be used to simultaneously receive information on two independent frequency channels. One TDMA transmitter shall be used to alternate TDMA transmissions on two independent frequency channels.

Data transmissions shall default to AIS 1 and AIS 2 unless otherwise specified by a competent authority, as described in 7.4.1 and Annex A.

7.2.1.2 Bandwidth

The class B AIS shall operate on 25 kHz channels according to Recommendation ITU-R M.1084-4 and Appendix 18 of the Radio Regulations.

7.2.1.3 Modulation scheme

The modulation scheme is bandwidth adapted frequency modulated Gaussian filtered minimum shift keying (GMSK/FM). The NRZI encoded data shall be GMSK coded before frequency modulating the transmitter.

7.2.1.4 Training sequence

Data transmission should begin with a 24-bit demodulator training sequence (preamble) consisting of one segment synchronisation. This segment should consist of alternating zeros and ones (0101....). This sequence always starts with a 0.

7.2.1.5 Data encoding

The NRZI waveform is used for data encoding. The waveform is specified as giving a change in the level when a zero (0) is encountered in the bit stream.

Forward error correction, Interleaving or Bit scrambling is not used.

7.2.1.6 DSC operation

The Class B"CS" AIS shall be capable of receiving DSC channel management commands. It shall either have a dedicated receive process, or it shall be capable of retuning its TDMA receivers to ch70 on a time sharing basis, with each TDMA receiver taking alternate turns to monitor ch70 (details see Annex A).⁶

7.2.2 Transmitter requirements

7.2.2.1 Transmitter parameters

Transmitter parameters shall be as given in Table 4.

Table 4 Transmitter parameters

Transmitter parameters	Required results	Condition
Frequency error	± 500 Hz normal ± 1000 Hz extreme	
Carrier power	31,8 dBm ± 3 dB normal ± 5 dB extreme	conducted
Modulation spectrum	-25 dBW -60 dBW	$\Delta f_c < \pm 10$ kHz ± 25 kHz $< \Delta f_c < \pm 62,5$ kHz
Modulation accuracy	< 3400 Hz normal and extreme 2400 ± 480 Hz normal and extreme 2400 ± 240 Hz normal ± 480 Hz extreme 1740 ± 175 Hz normal ± 350 Hz extreme 2400 ± 240 Hz normal ± 480 Hz extreme	Bit 0, 1 Bit 2, 3 Bit 4 ... 31 Bit 32 ... 199 0101 Bit 32 ... 199 00001111
Power versus time characteristics	Transmission delay: 2083 μ s Attack time: ≤ 313 μ s Release time: ≤ 313 μ s Transmission duration: ≤ 23333 μ s	Nominal 1 time period transmission
Spurious emissions	-36 dBm -30 dBm	9 kHz ... 1 GHz 1 GHz ... 4 GHz

⁶ In some regions, the competent authority may not require DSC functionality
405-cdv-draft

7.2.3 Receiver requirements

Receiver parameters shall be as given in Table 5.

Table 5 receiver parameters

Receiver Parameters	Required results		
	Result in PER	Wanted signal	Unwanted signal(s)
Sensitivity	20%	-107 dBm normal 1 -101 dBm extreme -104 dBm normal at ±500 Hz offset	
Error at high input levels	2%	-77 dBm	-
	10%	-7 dBm	-
Co-channel rejection	20%	-101 dBm	-111 dBm -111 dBm normal at ±1kHz offset
Adjacent channel selectivity	20%	-101 dBm	-31 dBm normal
Spurious response rejection	20%	-101 dBm	-31 dBm 50 MHz ... 520 MHz
Intermodulation response rejection	20%	-101 dBm	-36 dBm
Blocking and desensitisation	20%	-101 dBm	-23 dBm (< 5 MHz) -15 dBm (> 5 MHz)
Spurious emissions	-57 dBm	9 kHz ... 1 GHz	
	-47 dBm	1 GHz ... 4 GHz	
1 normal and extreme test conditions as defined in 8.2			

7.3 Link layer

The Link layer specifies how data shall be packaged in order to apply error detection to the data transfer. The Link layer is divided into three (3) sublayers.

7.3.1 Link sublayer 1: Medium Access Control (MAC)

The MAC sublayer provides a method for granting access to the data transfer medium, i.e. the VHF data link. The method used shall be Time Division Multiple Access (TDMA).

7.3.1.1 Synchronisation

Synchronisation shall be used to determine the nominal start of the CS time period (T_0).

7.3.1.1.1 Sync mode 1: AIS Stations other than Class B"CS" is received

If there are other AIS stations complying with IEC 61993-2 or IEC 62320-1 are received, the Class B CS shall synchronise its time-periods to their scheduled position reports (suitable account shall be taken of the propagation delays from the individual stations). This applies to message types 1, 2, 3, 4, 18, 19 as far as they are providing position data and have not been repeated (repeat indicator = 0).

Synchronisation jitter shall not exceed ± 3 bits ($\pm 312 \mu\text{s}$).

If these AIS stations are no longer received, the unit shall maintain synchronisation for a minimum of 30 sec and switch back to sync mode 2 after that.

Time periods that are reserved by a Base Station using message 20 shall be respected within the synchronisation jitter requirement.

Other synchronisation sources fulfilling the same requirements are allowed (optionally) instead of the above.

7.3.1.1.2 Sync mode 2: no Station other than Class B"CS" is received

In the case of a population of Class B"CS" stations alone (in the absence of any other class of station that can be used as a synchronisation source) the Class B"CS" station shall determine the start of time-periods (T_0) according to its internal timing.

If the Class B"CS" unit receives an AIS station that can be used as a synchronisation source (being in sync mode 2) it shall evaluate timing and synchronise its next transmission to this station.

7.3.1.2 Carrier Sense (CS) detection method

Within a time window of $1250 \mu\text{s}$ starting at $833 \mu\text{s}$ and ending at $2083 \mu\text{s}$ after the start of the time period intended for transmission (T_0) the AIS Class B"CS" shall detect if that time period is used (CS detection window).

Note: Signals within the first 8bit ($833 \mu\text{s}$) of the time period are excluded from the decision (to allow for propagation delays and ramp down periods of other units).

The Class B"CS" AIS shall not transmit on any time period when during the CS detection window a signal level greater than the "CS detection threshold" (7.3.1.3) is detected. The transmission of a CS-TDMA packet shall commence 20 bits ($T_A = 2083 \mu\text{s} + T_0$) after the nominal start of the time period (see Figure 2).

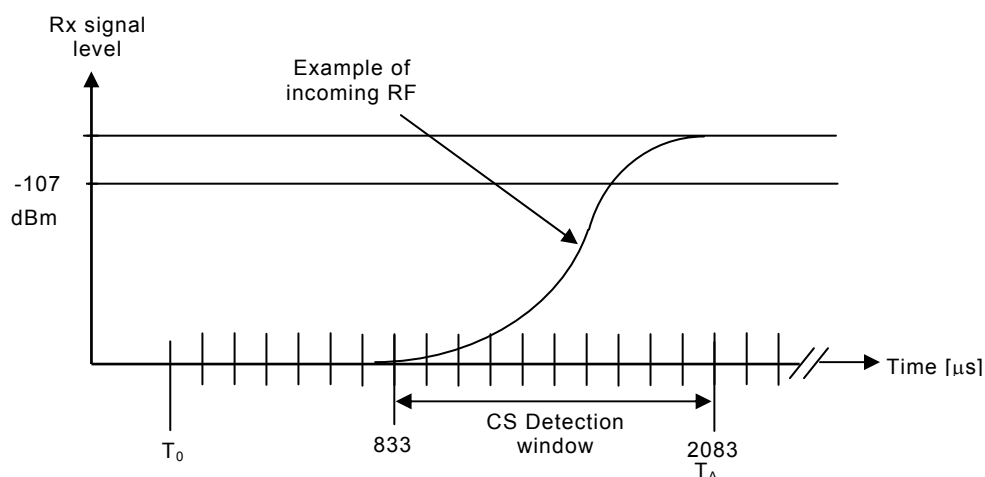


Figure 2 Carrier sense timing

7.3.1.3 CS detection threshold

The CS detection threshold shall be determined over a rolling 60 sec interval. The threshold shall be determined by measuring the minimum energy level (representing the background

noise) plus an offset of 10 dB. The minimum CS detection threshold shall be -107 dBm and background noise shall be tracked for a range of at least 30 dB (-77 dBm).⁷

7.3.1.4 VDL access

The transmitter shall begin transmission by turning on the RF power immediately after the duration of the carrier sense window (T_A).

The transmitter shall be turned off after the last bit of the transmission packet has left the transmitting unit; nominal transmission end is T_E (assuming no bit stuffing).

The access to the medium is performed as shown in Figure 3 and Table 6:

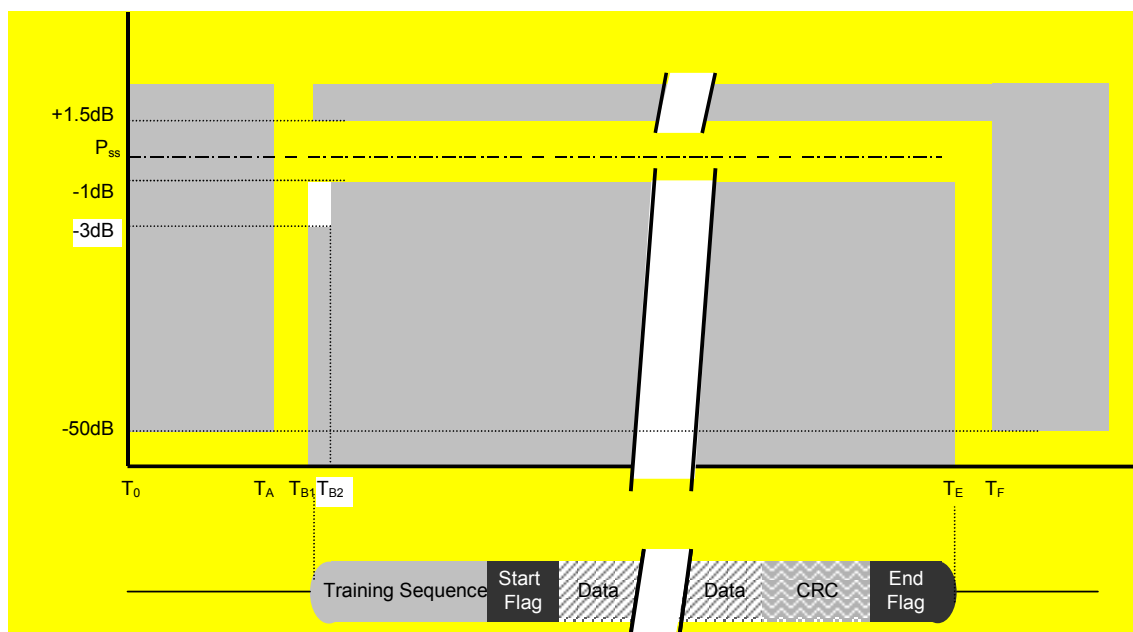


Figure 3 Power versus time mask

Table 6 Definition of timings for Figure 3

Reference	bits	Time	Definition
T_0	0	0 ms	Start of candidate transmission time period
T_A	20	2,083 ms	Power shall exceed -50 dB of P_{ss}
T_B	T_{B1} 23	2,396 ms	Power shall reach within +1,5 or -3 dB of P_{ss}
	T_{B2} 25	2,604 ms	Power shall reach within +1,5 or -1 dB of P_{ss}
T_E (plus 1 stuffing bit)	248	25,833 ms	Power shall still remain within +1,5 or -1 dB of P_{ss}
T_F (plus 1 stuffing bit)	251	26,146 ms	Power shall reach -50 dB of P_{ss} and stay below this

⁷ The following example is compliant with the requirement:

Sample the RF signal strength at a rate > 1 kHz, average the samples over a sliding 20 ms period and over a 4 sec interval determine the minimum period value. Maintain a history of 15 such intervals. The minimum of all 15 intervals is the background level. Add a fixed 10 dB offset to give the CS detection threshold.

There shall be no modulation of the RF after the termination of transmission (T_E) until the power has reached zero and next time division begins (T_G).

7.3.1.5 VDL State

The VDL State is based on the result of the carrier sense detection (7.3.1.2) for a time period. A VDL time period can be in one of the following states:

- **FREE:** The time period is available and has not been identified as used in reference to 7.3.1.2.
- **USED:** The VDL has been identified as used in reference to 7.3.1.2.
- **UNAVAILABLE:** Time periods shall be indicated as “UNAVAILABLE” if they are reserved by Base Stations using message 20 regardless of their range.

Time-periods indicated as “UNAVAILABLE” shall not be considered as a candidate time-period for use by own station and may be used again after a timeout. The timeout shall be 3 min if not specified or as specified in message 20.

7.3.2 Link sublayer 2: Data Link Service (DLS)

The DLS sublayer provides methods for:

- data link activation and release;
- data transfer or
- error detection and control.

7.3.2.1 Data link activation and release

Based on the MAC sublayer the DLS will listen, activate or release the data link. Activation and release shall be in accordance with 7.3.1.4.

7.3.2.2 Data transfer

Data transfer shall use a bit-oriented protocol which is based on the High-Level Data Link Control (HDLC) as specified by ISO/IEC 3309: 1993 – Definition of packet structure. Information packets (I-Packets) shall be used with the exception that the control field is omitted (see Figure 4).

7.3.2.2.1 Bit stuffing

The bit stream shall be subject to bit stuffing. This means that if five (5) consecutive ones (1's) are found in the output bit stream, a zero shall be inserted. This applies to all bits except the data bits of HDLC flags (Start flag and End flag, see Figure 4).

7.3.2.2.2 Packet format

Data is transferred using a transmission packet as shown in Figure 4:

Start-Buffer	Training sequence	Start flag	Data	FCS	End flag	End-Buffer
---------------------	--------------------------	-------------------	-------------	------------	-----------------	-------------------

Figure 4 Transmission packet

The packet shall be sent from left to right. This structure is identical to the general HDLC structure, except for the training sequence. The training sequence shall be used in order to

synchronise the VHF receiver as described in 7.2.1.4. The total length of the default packet is 256 bits. This is equivalent to 26,7 ms.

7.3.2.2.3 Start-Buffer

The Start-Buffer (refer to Table 7) is 23 bits long and consists of:

- CS-Delay 20 bits
 - Reception delay (sync jitter + distance delay)
 - Own synchronisation jitter (relative to synchronisation source)
 - Ramp-up (received Message)
 - CS detection window
- Ramp Up (own transmitter) 3 bits

Table 7 Start buffer

Seq.	Description	Bits	Note
1	Reception delay (synchronisation jitter + distance delay)	5	Class A: 3 bits of jitter (IEC61993-2) + 2 bits (30 NM) distance delay; Base station: 1 bit of jitter (IEC61993-2) + 4 bits (60 NM) distance delay
2	Own synchronisation jitter (relative to synchronisation source)	3	3bits according to ITU-R M.1371
3	Ramp-up (received Message)	8	referring to the Standard IEC 61993-2, start of detection window (from a practical observation all observed transponders were fully ramped up after 6 bits)
4	Detection window	4	
5	Ramp-Up (own transmitter)	3	
	total	23	

7.3.2.2.4 Training sequence

The training sequence shall be a bit pattern consisting of alternating 0's and 1's (010101010...).

Twenty- four bits of preamble are transmitted prior to sending the flag. This bit pattern is modified due to the NRZI mode used by the communication circuit. See Figure 5.

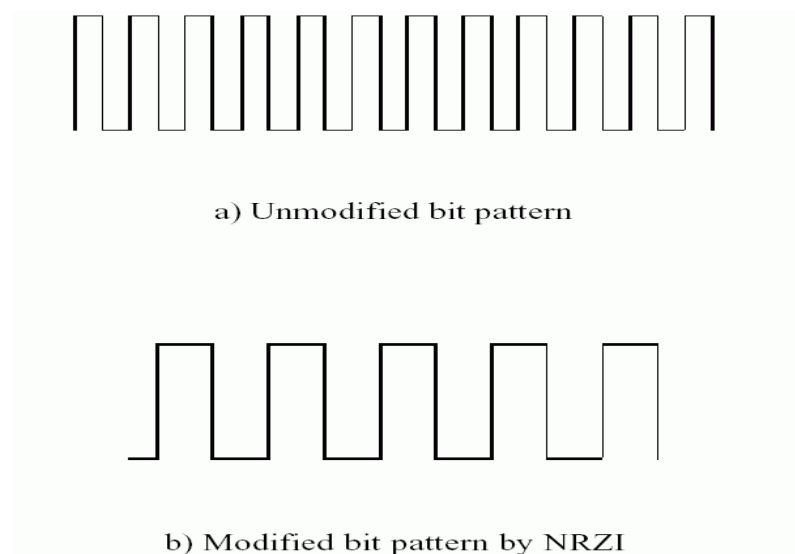


Figure 5 Training sequence

7.3.2.2.5 Start flag

The start flag shall be 8 bits long and consists of a standard HDLC flag. It is used to detect the start of a transmission packet. The Start flag consists of a bit pattern, 8 bits long: 01111110 (7Eh). The flag shall not be subject to bit stuffing, although it consists of 6 bits of consecutive ones (1's).

7.3.2.2.6 Data

The data portion in the default transmission packet transmitted in 1 time period is a maximum of 168 bits.

7.3.2.2.7 FCS

The FCS (Frame Check Sequence) uses the Cyclic Redundancy Check (CRC) 16-bit polynomial to calculate the checksum as defined in ISO/IEC 3309: 1993. All the CRC bits shall be pre-set to one (1) at the beginning of a CRC calculation. Only the data portion shall be included in the CRC calculation (see Figure 6).

7.3.2.2.8 End flag

The end flag is identical to the Start flag as described in 7.3.2.2.5.

7.3.2.2.9 End-Buffer

- bit stuffing 4 bits

(Note: the probability of 4 bits of bit stuffing is only 5% greater than that of 3 bit; refer to ITU-R M.1371-1 A2 3.2.2.8.1)

- Ramp Down 3 bits
- Distance Delay 2 bits

(Note: a buffer value of 2 bits is reserved for a distance delay equivalent to 30 NM for own transmission)

A repeater delay is not applicable (Duplex Repeater Environment is not supported).

7.3.2.3 Summary of the transmission packet

The data packet is summarised as shown in Table 8:

Table 8 Summary of the transmission packet

Action	Bits	Explanation
Start-buffer:		
CS-delay	20	T_0 to T_A in Figure 6
Ramp up	3	T_A to T_B in Figure 6
Training sequence	24	necessary for synchronisation
Start flag	8	in accordance with HDLC (7Eh)
Data	168	default
CRC	16	in accordance with HDLC
End flag	8	in accordance with HDLC (7Eh)
End-buffer:		
Bit stuffing	4	
Ramp down	3	
Distance delay	2	
Total	256	

7.3.2.4 Transmission timing

Table 9 and Figure 6 show the timing of the default transmission packet (one time division).

Table 9 Transmission timing

T(n)	Time (µs)	bit	Description
T_0	0	0	Start of time division; beginning of start buffer
T_A	2083	20	start of transmission (RF power is applied)
T_B	2396	23	End of start buffer; RF power and frequency stabilisation time, beginning of training sequence
T_C	4896	47	Beginning of start flag
T_D	5729	55	Beginning of data
T_E	25729	247	Beginning of end buffer; nominal end of transmission (assuming 0 bit stuffing)
T_F	26042	250	Nominal end of ramp down (power reaches -50 dBc)
T_G	26667	256	End of time period, start of next time period

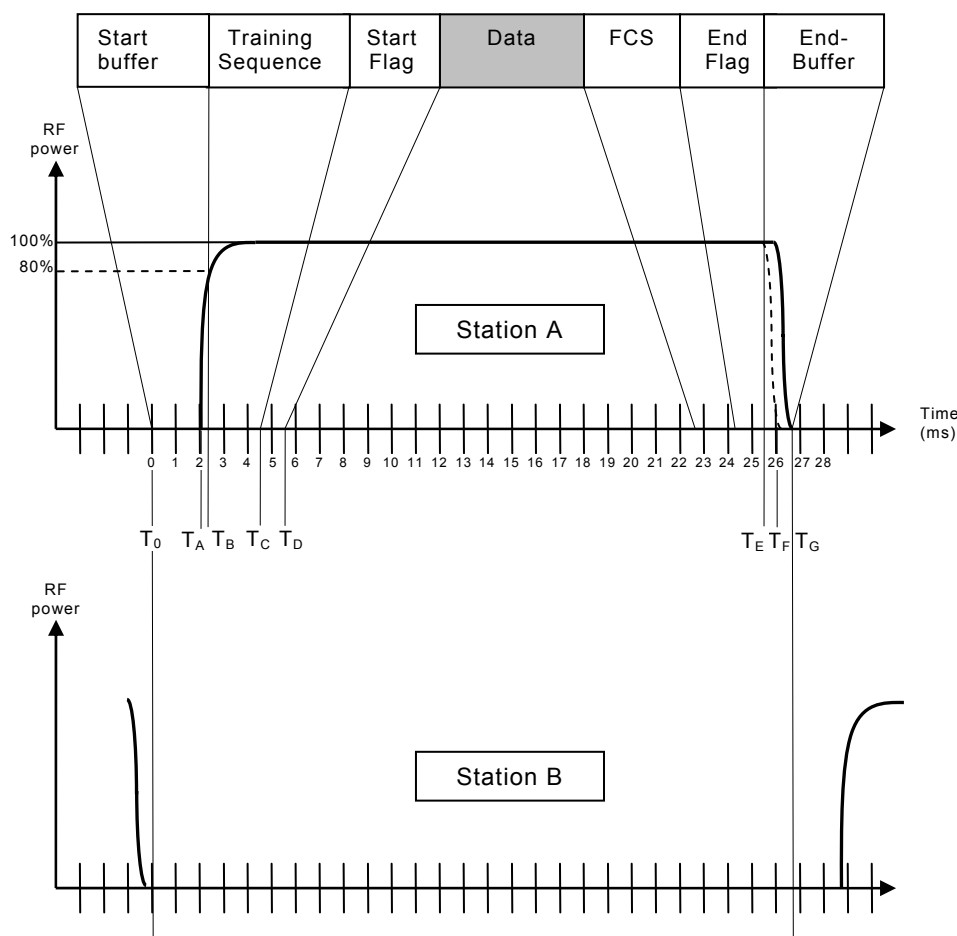


Figure 6 Transmission timing

7.3.2.5 Long transmission packets

Autonomous transmissions are limited to one time period. When responding to an interrogation by a Base Station for message 19, the response may occupy two time periods.

7.3.2.6 Error detection and control

Error detection and control shall be handled using the CRC polynomial as described in 7.3.2.2.7.

CRC errors shall result in no further action by the Class B“CS”.

7.3.3 Link sublayer 3 - Link Management Entity (LME)

The LME controls the operation of the DLS, MAC and the physical layer.

7.3.3.1 Access algorithm for scheduled transmissions

The Class B“CS” shall use a Carrier Sense (CS) TDMA access using transmission periods, which are synchronised to periods of RF activity on the VDL.

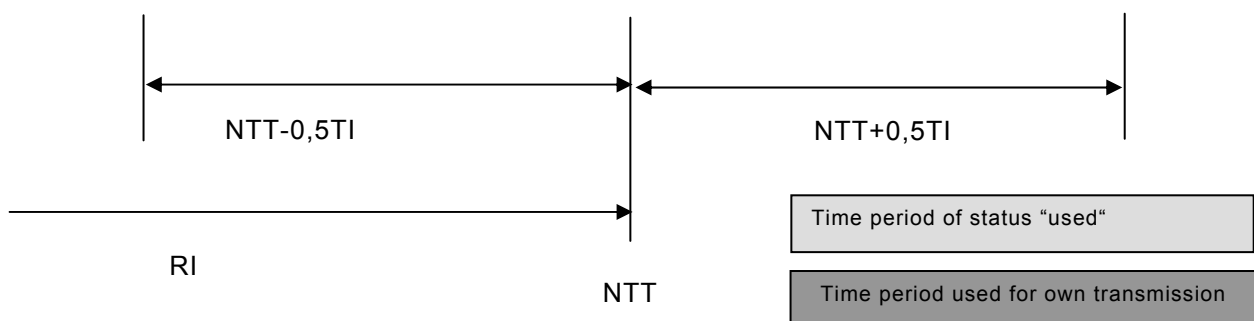
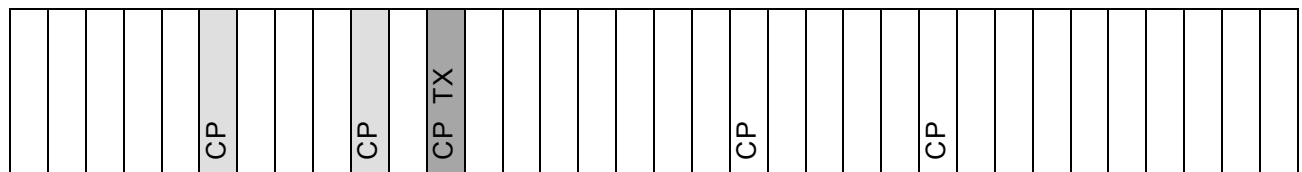
The access algorithm is defined by the following Parameters:

Table 10 Access parameters

term	description	value
Reporting Interval (RI)	reporting interval as specified in 6.5.2	5 sec ... 10 min
Nominal Transmission Time (NTT)	Nominal time-period for transmission defined by RI	
Transmission Interval (TI)	Time interval of possible transmission periods, centred around NTT	$TI = RI/3$ or 10 sec whichever is less
Candidate Period (CP)	Time-period where a transmission attempt is made (excluding time periods indicated unavailable)	
Number of CP in TI		10

The CS-TDMA algorithm shall follow the rules given below (refer to Figure 7):

- 1) Randomly define 10 Candidate Periods (CP) in the Transmission Interval (TI)
- 2) Starting with the first CP in TI, test for “Carrier Sense” 7.3.1.2 and transmit if the status of CP is “unused”, otherwise wait for the next CP
- 3) Transmission shall be abandoned if all 10 CPs are “used”

**Figure 7 Example for CS-TDMA access**

7.3.3.2 Access algorithm for unscheduled transmissions

Unscheduled transmissions, except responses to interrogations by a Base Station, shall be performed by assigning a Nominal Transmission Time within 25 sec of the request and shall use the access algorithm described in 7.3.3.1.

7.3.3.3 Modes of operation

There shall be three modes of operation.

- Autonomous (default mode)
- Assigned
- Interrogation

7.3.3.3.1 Autonomous

A station operating autonomously shall determine its own schedule for the transmission of its position reports.

7.3.3.3.2 Assigned

A station operating in the assigned mode shall use a transmission schedule assigned by a competent authority's Base Station. This mode is initiated by a group assignment command (Message 23, see 7.3.3.10).

The Assigned Mode shall affect only the transmission of position reports, and no other behaviour shall be affected. The transmission of position reports shall be only as directed by Message 23.

If a station receives this group assignment command and belongs to the group addressed by region and selection parameters it shall enter into assigned mode which shall be indicated by setting the 'Assigned Mode Flag' to "1".

To determine whether this group assignment command applies to the recipient station it shall evaluate all selector fields concurrently.

When commanded to a specific transmission behaviour (Tx/Rx mode or reporting interval), the mobile station shall tag it with a time-out, randomly selected between 4 and 8 minutes after the first transmission⁸. After the time-out has elapsed the station shall return to autonomous mode.

When commanded to a specific reporting rate, the AIS shall transmit the first position report with assigned rate after a time randomly selected between the time the message 23 has been received and the assigned interval to avoid clustering.

Any individual assignment command received shall take precedence over any group assignment command received; i.e. the following cases shall be applied:

- if Message 22 is individually addressed, the Tx/Rx mode field setting of Message 22 shall take precedence over the Tx/Rx mode field setting of Message 23;
- if Message 22 with regional settings is received, the Tx/Rx mode field setting of Message 23 shall take precedence over the Tx/Rx mode field setting of Message 22. In the case of Tx/Rx mode field, the receiving station reverts to its previous Tx/Rx mode regional operating setting after the Message 23 assignment has expired.

When a Class B"CS" station receives a quiet time command, it shall continue to schedule nominal transmission time periods (NTT) but shall not transmit Message 18 and 24 on either channel for the time commanded. Interrogations shall be answered during the quiet period. Transmissions of safety related messages may still be possible. After the quiet time has elapsed, transmissions shall be resumed using the transmission schedule as maintained during the quiet period.

Subsequent quiet time commands received during the first commanded quiet time shall be ignored.

The quiet time command shall override a reporting rate command.

⁸ note that because of the time-out, assignments may be reissued by the competent authority as needed. If a msg23 commanding a reporting interval of 6 or 10 min is not refreshed by the Base Station, the assigned station will resume normal operation after timeout and thus not establish the assigned rate.

7.3.3.3.3 Interrogation Mode

A station shall automatically respond to interrogation messages (Message 15) from a ship or competent authority. Operation in the interrogation mode shall not conflict with operation in the other two modes. The response shall be transmitted on the channel where the Interrogation message was received.

If interrogated for message 18 or 24 with no offset specified in message 15, the response shall be transmitted within 30 sec using the access algorithm as described in 7.3.3.2. If no free Candidate period has been found, one transmission retry shall be performed after 30 sec.

If interrogated by a Base Station with an offset given in message 15, the response shall be transmitted in the specified time period without applying the access algorithm as described in 7.3.3.2.

An interrogation by a Base Station for message 19 shall only be responded to if the interrogation message 15 contains an offset to the time period in which the response shall be transmitted ⁹.

Interrogations for the same message received before own response has been transmitted may be ignored.

7.3.3.4 Initialisation

At power on, a station shall monitor the TDMA channels for one (1) minute to synchronise on received VDL-transmissions (7.3.1.1) and to determine the CS detection threshold level (7.3.1.3). The first autonomous transmission shall always be the scheduled position report (Message 18) see 6.5.3.

7.3.3.5 Communication State for CS access

Because Class B"CS" does not use any Communication State information, the corresponding field in message 18 shall be filled with the following default value ¹⁰ :

1100000000000000110 .

7.3.3.6 VDL message use

Following Table 11 shows how the messages defined in M.1371/A2-3.2 shall be used by a Class B"CS" shipborne mobile AIS device. For further details refer to the appropriate section of M.1371.

⁹ The Base Station will reserve time periods by msg20 prior to interrogation.

¹⁰ A Class B"CS" station by default reports sync state 3 and does not report "number of received stations" (reference to ITU-R M.1371-1 table 12). Therefore it will not be used as sync source for other stations

Table 11 Use of VDL messages by a Class B"CS" AIS

msg No.	Name of message	M.1371 Ref.	Receive and process ¹¹	Transmit by own station	Remark
0	Undefined				
1	Position Report (Scheduled)	A2-3.3.8.2.1	opt	No	
2	Position Report (Assigned)	A2-3.3.8.2.1	opt	No	
3	Position Report (When interrogated)	A2-3.3.8.2.1	opt	No	
4	Base Station Report	A2-3.3.8.2.2	opt	No	
5	Static and Voyage Related Data	A2-3.3.8.2.3	opt	No	
6	Addressed Binary Message	A2-3.3.8.2.4	No	No	
7	Binary Acknowledge	A2-3.3.8.2.5	No	No	
8	Binary Broadcast Message	A2-3.3.8.2.6	Opt	No	
9	Standard SAR Aircraft Position Report	A2-3.3.8.2.7	Opt	No	
10	UTC and Date Inquiry	A2-3.3.8.2.8	No	No	
11	UTC / Date Response	A2-3.3.8.2.2	opt	No	
12	Safety Related Addressed Message	A2-3.3.8.2.9	no	No	Note: information can only be transferred via msg14
13	Safety Related Acknowledge	A2-3.3.8.2.5	No	No	
14	Safety Related Broadcast Message	A2-3.3.8.2.10	opt	opt	Transmit with predefined text only, see 7.3.3.7
15	Interrogation	A2-3.3.8.2.11	Yes	No	class A shipborne mobile station may interrogate for msg18 and 24 Class B"CS" shall respond with msg18 / msg24A and 24B Base station may also

¹¹ "receive and process" in this table means functionality visible for the user, e.g. output to an interface or display. For synchronisation it is necessary to receive and internally process messages according to 7.3.1.1; this applies to messages 1, 2, 3, 4, 18, 19.

msg No.	Name of message	M.1371 Ref.	Receive and process ¹¹	Transmit by own station	Remark
					interrogate for msg19
16	Assigned Mode Command	A2-3.3.8.2.12	No	No	(msg23 is applicable to the "CS" instead)
17	DGNSS Broadcast Binary Message	A2-3.3.8.2.13	Opt	No	
18	Standard Class B Equipment Position Report	A2-3.3.8.2.14	Opt	Yes	A Class B"CS" AIS shall indicate "1" for "CS" in flag bit 143
19	Extended Class B Equipment Position Report	A2-3.3.8.2.15	Opt	Yes	Transmit ONLY as response on Base Station interrogation
20	Data Link Management Message	A2-3.3.8.2.16	Yes	No	
21	Aids-to-Navigation Report	A2-3.3.8.2.17	Opt	No	
22	Channel Management Message	A2-3.3.8.2.18	Yes	No	Use of that function may be different in certain regions
23	Group Assignment		Yes	No	
24	Class B"CS" Static data		Opt	Yes	Part A and Part B
25 - 63	Undefined	None	No	No	Reserved for future use

7.3.3.7 Use of safety related message message 14 (optional)

The data contents of message 14 if implemented shall be predefined and the transmission shall not exceed one time period. Table 12 specifies the maximum number of data bits used for message 14 and is based on the assumption that the theoretical maximum of stuffing bits will be needed.

Table 12 Number of data bits for use with message 14

Number of time periods	Maximum data bits	Stuffing bits	Total buffer bits
1	136	36	56

The Class B"CS" AIS shall only accept the initiation of a message 14 once a minute by a user manual input. Automatic repetition is not allowed.

The message 14 may have precedence over message 18.

7.3.3.8 Message 18: Standard Class B CS equipment position report

The Standard Class B equipment position report shall be output periodically and autonomously.

Table 13 Contents of message 18

Parameter	Number of bits	Description
Message ID	6	Identifier for Message 18; always 18
Repeat indicator	2	Used by the repeater to indicate how many times a message has been repeated. 0-3; shall be 0 for Class B"CS" transmissions;
User ID	30	MMSI number
Reserved for regional or local applications	8	Reserved for definition by a competent regional or local authority. Shall be set to zero, if not used for any regional or local application. Regional applications should not use zero
SOG	10	Speed over ground in 1/10 knot steps (0-102.2 knots) 1 023 = not available, 1 022 = 102.2 knots or higher
Position accuracy	1	1 = high (<10 m) 0 = low (>10 m) shall be combined with RAIM information if available; see ch. 6.6.3
Longitude	28	Longitude in 1/10 000 min (± 180 degrees, East = positive (as per 2's complement), West = negative (as per 2's complement). 181 degrees (6791AC0 hex) = not available = default)
Latitude	27	Latitude in 1/10 000 min (± 90 degrees, North = positive (as per 2's complement), South = negative (as per 2's complement), 91 degrees (3412140 hex) = not available = default)
COG	12	Course over ground in $1/10^\circ$ (0-3 599). 3 600 (E10h) = not available = default; 3 601-4 095 shall not be used
True heading	9	Degrees (0-359) (511 indicates not available = default)
Time stamp	6	UTC second when the report was generated by the EPFS (0-59 60 if time stamp is not available, which shall also be the default value 61, 62, 63 are not used by the Class B"CS" AIS
Reserved for regional applications	2	Reserved for definition by a competent regional authority. Shall be set to zero, if not used for any regional application. Regional applications should not use zero
Class B unit flag	1	0 = non Class B "CS" unit 1 = Class B"CS" unit
Class B display flag	1	0 = No display available; not capable of displaying msg14 1 = Equipped with integrated display displaying msg14
Class B DSC flag	1	0 = not equipped with DSC function 1 = equipped with DSC function (dedicated or time-shared)
Class B band flag	1	0 = Capable of operating over the upper 525kHz band of the marine band 1 = Capable of operating over the whole marine band (irrelevant if „Class B Msg22 flag“ is 0)
Class B Msg22 flag	1	0 = No Frequency management via Msg22 , operating on AIS1, AIS2 only 1 = Frequency management via Msg22
Mode Flag	1	0 = Station operating in autonomous mode =default 1 = Station operating in assigned mode
RAIM-flag	1	RAIM flag of electronic position fixing device; 0 = RAIM not in use = default; 1 = RAIM in use (valid data for expected position error)
Communication state selector flag	1	1 = ITDMA communication state follows
Communication state	19	ITDMA communication state; refer to ch.7.3.3.5
Total number of bits	168	Occupies one time period

7.3.3.9 Message 24: Class B“CS” static data report

This message shall be used by Class B“CS” shipborne Mobile Equipment. The message consists of two parts. Message 24B shall be transmitted within 1 minute following message 24A.

In case of an interrogation for message 24, the response shall include part A and part B.

Table 14 Message 24 Part A:

Parameter	Number of bits	Description
Message ID	6	Identifier for Message 24; always 24
Repeat indicator	2	Used by the repeater to indicate how many times a message has been repeated. 0 = default; 3 = do not repeat any more
User ID	30	MMSI number
part number	2	Identifier for the message part number; always 0 for part A
Name	120	Maximum 20 characters 6-bit ASCII, @@@@@@@@@@@@@@@@@@@@ = not available = default
Total number of bits	160	Occupies one time period

Table 15 Message 24 Part B:

Parameter	Number of bits	Description
Message ID	6	Identifier for Message 24; always 24
Repeat indicator	2	Used by the repeater to indicate how many times a message has been repeated. 0 = default; 3 = do not repeat any more
User ID	30	MMSI number
part number	2	Identifier for the message part number; always 1 for part B
Type of ship and cargo type	8	0 = not available or no ship = default 1-99 = as defined in § 3.3.8.2.3.2 of ITU-R M.1371-1 100-199 = preserved, for regional use 200-255 = preserved, for future use
Vendor ID	42	Unique identification of the Unit by a Number as defined by the manufacturer (option; "@@@@@@@@" = not available = default).
Call Sign	42	7 × 6 bit ASCII characters, "@@@@@@@@" = not available = default.
Dimension of ship/reference for position	30	Dimensions of ship in meters and reference point for reported position (see ITU-R M.1371-1 Fig. 17 and § 3.3.8.2.3.3)
Total number of bits	162	Occupies one time period

7.3.3.10 Message 23: Group Assignment Command**Table 16 Contents of message 23**

Parameter	Number of bits	Description
Message ID	6	Identifier for message 23; always 23
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. 0 - 3; default = 0; 3 = do not repeat any more.
Source ID	30	MMSI of assigning station.
Spare	2	Spare. Shall be set to zero.
Longitude 1	18	Longitude of area to which the group assignment applies; upper right corner (north-east) ; in 1/10 min ($\pm 180^\circ$, East=positive, West=negative).
Latitude 1	17	Latitude of area to which the group assignment applies; upper right corner (north-east); in 1/10 min ($\pm 90^\circ$, North=positive, South=negative).
Longitude 2	18	Longitude of area to which the group assignment applies; lower left corner (south-west) ; in 1/10 min ($\pm 180^\circ$, East=positive, West=negative).
Latitude 2	17	Latitude of area to which the group assignment applies; lower left corner (south-west); in 1/10 min ($\pm 90^\circ$, North=positive, South=negative).
Station type	4	0 = all types of mobiles (default) ; 1 = reserved for future use; 2 = all types of Class B mobile stations ; 3 = SAR airborne mobile station; 4 = AtoN station; 5= Class B"CS" shipborne mobile station (IEC62287 only); 6 to 9 = regional use and inland waterways ; 10 to 15 = for future use
Type of ship and cargo type	8	0= all types (default) 1...99 see Table 18 of ITU-R M.1371-1 100...199 reserved for regional use 200...255 reserved for future use
spare	22	Reserved for future use. Not used. Shall be set to zero.
Tx/Rx mode	2	This parameter commands the respective stations to one of the following modes : 0 = TxA/TxB, RxA/RxB (default); 1 = TxA, RxA/RxB , 2 = TxB, RxA/RxB, 3 = reserved for future use
Reporting Interval	4	This parameter commands the respective stations to the reporting interval given in Table 17 .
Quiet Time	4	0 = default = no quiet time commanded ; 1 – 15 = quiet time of 1 to 15 min.
Spare	6	Spare. Not used. Shall be set to zero.
Total	160	Occupies one time period

Table 17 Reporting Interval Settings for use with message 23

Reporting Interval field setting	Reporting interval for msg18
0	As given by the autonomous mode
1	10 minutes
2	6 minutes
3	3 minutes
4	1 minute
5	30 seconds
6	15 seconds
7	10 seconds
8	5 seconds
9	Next shorter reporting interval
10	Next longer reporting interval
11 - 15	Reserved for future use

Note: When the dual channel operation is suspended by Tx/Rx mode command 1 or 2, the resulting reporting interval is twice the interval given in above table.

7.4 (M.1371/A2-4) Network layer

The network layer shall be used for:

- establishing and maintaining channel connections;
- management of priority assignments of messages;
- distribution of transmission packets between channels;
- data link congestion resolution

7.4.1 Dual channel operation

The normal default mode of operation shall be a two-channel operating mode, where the AIS simultaneously receives on both channels A and B in parallel.

The DSC process may use the receiving resources on a time-share basis as described in Annex A. Outside the DSC receiving periods the two TDMA receiving processes shall work independently and simultaneously on channels A and B.

For periodic repeated messages, the transmissions shall alternate between channels A and B. The alternating process shall be independent for message 18 and message 24.

Transmission of complete message 24 shall alternate between channels (all submessages to be transmitted on the same channel before alternating to the other channel).

Channel access is performed independently on each of the two parallel channels.

Responses to interrogations shall be transmitted on the same channel as the initial message.

For non-periodic messages other than those referenced above, the transmissions of each message, regardless of message type, shall alternate between channels A and B.

7.4.2 Channel management

Channel management shall be done according to ITU-R M.1371 A2/4.1 except:

- channel management commands shall only be accepted by message 22 and DSC command;
- the Class B"CS" AIS is only required to operate in the band specified in 6.2 with a channel spacing of 25kHz. It shall stop transmitting if commanded to a frequency outside its operating capability.

		step	Region 1 Channel A (frequ.1)	Region 1 Channel B (frequ.2)	Region 2 Channel A (frequ.3)	Region 2 Channel B (frequ.4)
Region 1		A	x	X		
	Transitional zone	B	xx		xx	
Region 2	Transitional zone	C	xx		xx	
		D			x	x

X transmit with nominal reporting rate

XX transmit with doubled reporting rate

When entering (step A to B) or leaving (step C to D) a transitional zone the Class B"CS" AIS shall continue to evaluate the CS threshold taking into account the noise level of the old channel initially and the new channel as time progresses. It shall continuously transmit (on frequ.1 and frequ.3 in step B) with the required rate maintaining its schedule.

7.4.3 Distribution of transmission packets

7.4.3.1 Assigned Reporting intervals

A competent authority may assign reporting intervals to any mobile station by transmitting group assignment Message 23. An assigned reporting interval shall have precedence over the nominal reporting rate; a reporting interval of less than 5sec is not required.

7.4.4 Data link congestion resolution

The Class B"CS" AIS shall only transmit if it has verified that the time period intended for transmission does not interfere with transmissions made by stations complying with IEC 61993-2, IEC 62320-1 or IEC 62320-2. In case of high channel load the Class B"CS" AIS might not be able to transmit.

7.5 (M.1371/A2-5) Transport layer

The transport layer shall be responsible for:

- converting data into transmission packets of correct size;
- sequencing of data packets;
- interfacing protocol to upper layers (see 6.7.3).

7.5.1 Transmission packets

A transmission packet is an internal representation of some information, which can ultimately be communicated to external systems. The transmission packet is dimensioned so that it conforms to the rules of data transfer.

The transport layer shall convert data intended for transmission, into transmission packets.

The Class B"CS" AIS shall only transmit message 18, 19 and 24 (Table 11) and may optionally transmit message 14.

7.5.2 Sequencing of data packets

The Class B"CS" AIS is periodically transmitting the standard position report message 18.

This periodic transmission shall use the access scheme described in 7.3.3.1. If a transmission attempt fails because of e.g. high channel load, this transmission shall not be repeated. Additional sequencing is not necessary.

8 Test conditions

8.1 General

When a requirement in this standard is different from IEC 60945, the requirement in this standard shall take precedence.

8.2 Normal and extreme test conditions

8.2.1 Normal test conditions

8.2.1.1 Temperature and humidity

Temperature and humidity shall be within following range:

Temperature	+15° to +35° C
Humidity	20% to 75%

8.2.1.2 Power supply

The normal power supply for the tests shall be the nominal voltage as defined by the manufacturer $\pm 3\%$.

8.2.2 Extreme test conditions

Test under extreme test conditions shall be a combination of high temperature (dry heat) and upper limit of supply voltage applied simultaneously and low temperature and lower limit of supply voltage applied simultaneously (see 9).

During type testing of battery operated equipment the power source to the equipment may be replaced by a test power source, capable of producing normal and extreme test voltages.

8.3 Test Signals

Transmitters may have limitations concerning their maximum continuous transmit time and/or their transmission duty cycle. It is intended that such limitations are respected during testing.

8.3.1 Standard Test Signal Number 1

A DSC modulated data signal comprising an infinite length of 01010101 (dotting pattern; refer to ITU-R M.825).

8.3.2 Standard Test Signal Number 2

A series of 010101 as the data within an AIS message frame, with header, start flag, end flag and CRC. NRZI is not applied to the 010101 bit stream or CRC (i.e. unaltered "On Air" data).

8.3.3 Standard Test Signal Number 3

A series of 00001111 as the data within an AIS message frame, with header, start flag, end flag and CRC. NRZI is not applied to the 00001111 bit stream or CRC.

8.3.4 Standard Test Signal Number 4

A Pseudo Random Sequence (PRS) as specified in ITU/T 0.153 as the data within an AIS message frame with header, start flag, end flag and CRC. NRZI is not applied to the PRS stream or CRC.

8.3.5 Standard Test Signal Number 5

This test signal consists of 200 packets grouped into clusters of 4 as described in Figure 8. Each cluster consists of 2 consecutive transmissions of the packets described in Table 18.

NRZI shall be applied to every packet. After sending packet 1 and 2 the notional initial state of the NRZI process shall be inverted and then packet 1 and 2 repeated.

Between every transmitted packet there shall be at least 2 free time periods. The RF carrier shall be switched off between packets to simulate normal operation.



Figure 8 Format for repeating four-packet cluster

Table 18 - Content of first two packets

Packet	Parameter	Bits	Contents	Comment
1	Training	22	0101....0101	Preamble reduced by 2 bits because of ramp-up overlap
	Start flag	8	01111110	
	Data	168	Pseudo Random	As per Table 19
	CRC	16	Calculated	
	End flag	8	01111110	
2	Training	22	1010....1010	Preamble reduced by 2 bits because of ramp-up overlap
	Start flag	8	01111110	
	Data	168	Pseudo Random	As per Table 19
	CRC	16	Calculated	
	End flag	8	01111110	

Table 19 Fixed PRS data derived from ITU/R.0.153

Address	Contents (HEX)							
0-7	0x04	0xF6	0xD5	0x8E	0xFB	0x01	0x4C	0xC7
	0000.0100	1111.0110	1101.0101	1000.1110	1111.1011	0000.0001	0100.1100	1100.0111
8-15	0x76	0x1E	0xBC	0x5B	0xE5	0x92	0xA6	0x2F
	0111.0110	0001.1110	1011.1100	0101.1011	1110.0101	1001.0010	1010.0110	0010.1111
16-20	0x53	0xF9	0xD6	0xE7	0xE0	21 Byte's = 168 bits (+ 4 stuffed bits) , CRC = 0x3B85		
	0101.0011	1111.1001	1101.0110	1110.0111	1110.0000			

8.4 Test arrangements

8.4.1 Standard Test environment

8.4.1.1 Test setup

The EUT is tested in an environment using test equipment to simulate and to log VDL-messages. Standard environment consists of at least 1 simulated Class A AIS test target transmitting message 1 with a reporting interval of 10 sec (according to IEC 61993. The signal input level at the RF input port of the EUT for any simulated target shall be -60dBm \pm 5dB. EUT is stationary (SOG<2 kn). Operation is checked on channels in the maritime mobile band as applicable.

8.4.1.2 DSC functionality

DSC functionality where provided shall be disabled except for the DSC tests according to Annex A.

8.4.1.3 Position test input

An appropriate test input shall be provided for simulated position information in IEC 61162-1 format. The rules for an external position sensor as defined in 6.3 shall not apply to this test input.

8.4.1.4 Test signals applied to the receiver input

Sources of test signals for application to the receiver input shall be connected in such a way that the source impedance presented to the receiver input is 50 Ω irrespective of whether one or more signals using a combining network are applied to the receiver simultaneously.

The levels of the test signals at the receiver input terminals (RF socket) shall be expressed in terms of dBm.

8.4.1.5 Waiver for receivers

If the manufacturer declares that both TDMA receivers are identical, the test shall be limited to one receiver and the test for the second receiver shall be waived. The test report shall mention this.

8.4.1.6 Artificial antenna (dummy load)

Tests shall be carried out using an artificial antenna, which shall be a non-reactive non-radiating load of 50 Ω connected to the antenna connector.

NOTE: Some of the methods of measurement described in this standard for the transmitters, allow for two or more different test set ups in order to perform those measurements. The corresponding figures illustrate therefore one particular test set up, and are given as examples. In many of those figures, power attenuators (providing a non-reactive non-radiating load of 50 Ω to the antenna connector) have been shown. These attenuators are not "artificial antennas" as defined in 8.4.1.6. The method of measurement used shall be stated in the test report.

8.4.1.7 Facilities for access

The EUT shall be fitted with a port for the purpose of the tests to monitor transmitted and received messages following the protocol of IEC 61162. If standard external interfaces are available, these will be used for the tests. Where further access means are required to perform any specific test, these shall be provided by the manufacturer.

8.4.2 Modes of operation of the transmitter

For the purpose of the measurements according to this standard, there shall be a means to operate the transmitter unmodulated or, alternatively, the method of obtaining an unmodulated carrier or special types of modulation patterns may be decided by agreement

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between the manufacturer and the test laboratory. It shall be described in the test report. It may involve suitable temporary internal modifications of the equipment under test.

8.4.3 Measurement uncertainties

Maximum values of absolute measurement uncertainties shall be as follows:

RF frequency.....	$\pm 1 \times 10^{-7}$
RF power	± 0.75 dB
Adjacent channel power	± 5 dB
Conducted spurious emission of transmitter	± 4 dB
Conducted spurious emission of receiver	± 3 dB
Two-signal measurement	± 4 dB
Three-signal measurement	± 3 dB
Radiated emission of transmitter	± 6 dB
Radiated emission of receiver	± 6 dB
Transmitter timing characteristics	± 1 bit (104µs)
Transmitter transient frequency (frequency difference)	± 250 Hz

For the test methods according to this standard, these uncertainty figures are valid to a confidence level of 95 %.

The interpretation of the results recorded in a test report for the measurements described in this standard shall be as follows:

- the measured value related to the corresponding limit shall be used to decide whether an equipment meets the requirements of this standard;
- the actual measurement uncertainty of the test laboratory carrying out the measurements, for each particular measurement, shall be included in the test report;
- the values of the actual measurement uncertainty shall be, for each measurement, equal to or lower than the figures given in this clause (absolute measurement uncertainties).

9 Power supply, Environmental and EMC tests

9.1 Test summary

Tests shall be done in accordance with IEC60945 as specified in the following table:

Test title Note: Left-adjusted bold headings refer to headings in IEC 60945	Section of IEC 60945	Comment
Inter-unit connection	4.2.4 (6.4)	(interfaces other than IEC 61162 are allowed; see 6.7.3 waiver *)
Power supply	4.3	
Extreme power supply	4.3.1 (7.1)	Lower limit of extreme DC power supply shall be -20% of nominal voltage waiver *)
Excessive conditions	4.3.2 (7.2)	waiver *)
Power supply short-term variation and power supply failure	4.3.3 (7.3, 7.4)	waiver *)
Undervoltage (brown out) test		See 9.4; waiver *)
Durability and resistance to environmental conditions	4.4 (8)	
Dry heat	8.2.1;	reduce time to 5h ; waiver *) Note: 8.2.2 is covered by ch. 11
Damp heat	8.3;	waiver *)
Low temperature (portable)	Storage: 8.4.1 Functional: 8.4.2	waiver *)
Thermal shock (portable)		no
Drop (portable)		no
Vibration/shock		See chapter 9.2
Rain and spray (exposed)	Do 8.8	waiver *)
Immersion		no
Solar radiation	Yes	waiver *)
Oil resistance	Yes;	waiver *)
Corrosion	Yes	waiver *)
Interference	4.5	
Electromagnetic emission	9	
Immunity to electromagnetic environment	10	
Compass safe distance	4.5.3 (11.2) Do 11.2	waiver *): manufacturer may take liability for the figures given for CSD
Safety precautions	4.6	
Protection against dangerous voltages	4.6.1 (12.1) Do 12.1	waiver *)
Electromagnetic radiofrequency radiation	4.6.2 (12.2 12.3)	
X-radiation	4.6.3 (12.4)	

*) This test may be waived if the manufacturer is able to produce evidence that the requirement is fulfilled.

9.2 Vibration/shock

9.2.1 Vibration

9.2.1.1 Method of measurement

The vibration test shall be done using sweep range and amplitude as defined in 60945 at a sweep rate of 0.2 octaves per minute (which is about 40min per sweep).

One sweep up (2...100Hz) shall be followed by a sweep down (100...2Hz) for each axis keeping the EUT operational throughout.

9.2.1.2 Results required

Verify that the EUT stays operational throughout the test; a successful performance check shall be carried out at the end of the test period.

9.2.2 Shock

9.2.2.1 Purpose

The test provides a method by which responses of components and equipment comparable with those likely to be experienced in practice in the operational environment can be produced in the test laboratory.

This test only applies to exposed equipment.

9.2.2.2 Method of measurement

The EUT shall be mounted in the normal operating orientation and shall be kept operational during the shocks. The EUT shall be mechanically connected to the shock machine by its normal means of attachment. The peak acceleration shall be 100 m/s², pulse shape shall be half sine and duration 25 msec.

The shock pulse shall be measured by an accelerometer placed at the EUT fixing point nearest to the centre of the table surface.

- a) Carry out a performance check.
- b) Apply three successive upward shocks with the EUT operative
- c) Check for external indications of damage.
- d) Carry out a second performance check.

9.2.2.3 Results required

There shall be no external indications of damage and there shall be no detectable degradation in performance during the performance check.

9.3 Performance tests / checks

Performance Tests: for the purpose of testing Class B AIS, a Performance Check shall be carried out.

For the Performance Check, repeat test 10.2.1.1, 10.2.1.2 .

9.4 Undervoltage test (brown out)

Purpose

This test simulates the situation where the nominal supply voltage drops to below acceptable levels and then recovers over a medium time period. This is consistent with the performance of a flat or unhealthy battery when an engine is started.

Method of test

Operate the EUT at the nominal supply voltage as indicated by the manufacturer.

- a) Gradually reduce the supply voltage to 40% of the nominal supply voltage over a time period of 30s
- b) Gradually increase the supply voltage back to 80% of the nominal supply voltage over a time period of 30s.

Required result

- a) The unit shall not enter into any undefined or undesirable state as verified by a performance check.
- b) The EUT shall recover and be fully operational as verified by a performance check

10 Operational tests

10.1 General

10.1.1 Quality assurance

Method of measurement

By inspection of documentation

Required results

The requirements of 4.1.2 shall be met.

10.1.2 Safety of operation

Method of measurement

By inspection

Required results

The requirements of 4.1.3 shall be met.

10.1.3 Additional features

Method of measurement

Operate the EUT in standard test environment. Repeat tests that might be affected by the additional feature.

Required results

The requirements of 4.1.4 shall be met.

10.2 (4.1.5) Modes of operation

10.2.1 Autonomous mode

10.2.1.1 Transmit Position reports

Method of measurement

Set up standard test environment. Record the VDL communication and check for messages transmitted by the EUT.

Required results

Confirm that the EUT transmits messages 18 and 24 following the nominal schedule and alternating between channels A and B.

10.2.1.2 Receive Class A position reports

Method of measurement

Set up standard test environment.

- a) Switch on test targets, then start operation of the EUT
- b) Start operation of the EUT, then switch on test targets
- c) Transmit test targets using same time periods on channels A and B

Check the VDL communication, test output, and where provided, display or external Interface of the EUT.

Required results

Confirm that EUT receives continuously under conditions a), b) and c) and, where provided, outputs the received messages on the external interface or display.

10.2.1.3 Receive Class B"CS" position reports

This test is only applicable if a display or display interface for the received messages is provided.

Method of measurement

Set up standard test environment. Simulate at least one additional Class B"CS" test target (bit stuffing shall not increase 4 bit)

Check the VDL communication, test output, and display or external Interface of the EUT.

Required results

Confirm that EUT receives the Class B"CS" test target continuously and, where provided, outputs the received messages 18 and 24 on the external interface.

10.2.1.4 Receive in adjacent time periods

Method of measurement

Set up standard test environment. Simulate additional targets so that the first 4 of each 5 time periods are used. The reporting rate may be increased for the purpose of this test.

Check the VDL communication, test output, and where provided, display or external Interface of the EUT.

Required results

Confirm that EUT continuously receives messages in the time periods adjacent to own transmission period with an acceptable loss of 5%.

10.2.1.5 Rx performance test

Method of measurement

Set up standard test environment. Simulate additional targets so that 9 of 10 time periods are used.

Check the VDL communication, test output, and where provided, display or external Interface of the EUT.

Required results

Confirm that EUT continuously receives messages and, where provided, outputs the received messages on the external interface with a loss of not more than 5%.

10.2.2 Assigned mode**10.2.2.1 (4.1.5.2) Group assignment****Method of measurement**

Set-up standard test environment and operate EUT in autonomous mode. Transmit a group assignment command message 23 to the EUT addressing stations by:

Region,
station type and
type of ship

and commanding for

TX/Rx mode
Reporting rate
Quiet time

Record transmitted messages.

Required results

Confirm that the EUT transmits position reports message 18 according to the defined parameters and reverts to standard reporting rate after 4 to 8 min.

Confirm that the operation of the EUT is not affected when not addressed.

10.2.2.2 (4.1.5.2) Base station reservations**Method of measurement**

Set-up standard test environment and operate EUT in autonomous mode. Transmit a reservation message 20 to the EUT specifying reserved time periods.

Record transmitted messages.

Required results

Confirm that the EUT transmits position reports message 18 without using reserved time periods.

10.2.3 Polled mode / Interrogation response**10.2.3.1 Interrogation for message 18, 24****Method of measurement**

Set-up standard test environment and operate EUT in autonomous mode. Apply an interrogation message (message 15; EUT as destination) to the VDL according to message table (ITU-R M.1371 table13) for responses with message 18, message 24

- a) with transmission offset = 0
- b) with transmission offset = defined value
- c) with a message 23 “quiet time” command transmitted before the interrogation

Record transmitted messages and frame structure.

Required results

Check that the EUT transmits the appropriate interrogation response message as requested after defined transmission offset. Confirm that the EUT transmits the response on the same channel as where the interrogation was received.

10.2.3.2 Interrogation for message 19

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode. Apply an interrogation message (message 15; EUT as destination) to the VDL according to message table (M.1371 table13) for responses with message 19

- a) with transmission offset =0
- b) with transmission offset = defined value

Record transmitted messages and frame structure.

Required results

Check that

- a) the EUT does not respond
- b) the EUT transmits the appropriate interrogation response message as requested after defined transmission offset.

Confirm that the EUT transmits the response on the same channel as where the interrogation was received and that the data content is identical with that in message 24.

10.3 (4.1.5) Messages extending one time period

Method of measurement

Check the documentation for a possibility to initiate transmission of messages longer than one time period.

Required results

It shall not be possible for the user to initiate the transmission of messages longer than one time period.

10.4 (6.2) Channel selection

10.4.1 Valid channels

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode. Switch the EUT to different channels within the operating band as specified in 6.2 by transmission of channel management message (message 22) broadcast and addressed to EUT,

Record the VDL messages on the designated channels and check “band flag” and “message 22 flag” in message 18. (note: DSC command covered in ch.17)

Required results

Confirm that the EUT switches to the required Channel accordingly.

10.4.2 Invalid channels

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode. Switch the EUT to channels outside the operating band as specified in 6.2.

Record the VDL messages on the designated channels and check “band flag” and “message 22 flag” in message 18 before.

Required results

Confirm that the EUT does not switch to the respective channels and stops transmissions.

10.5 Internal GNSS receiver

Relevant tests according to IEC 61108-1ed.2 shall be performed with regard to

- Position accuracy, static
- Position accuracy, dynamic
- COG/SOG accuracy
- Position update
- Status indications (incl. RAIM, where fitted)

10.6 AIS Information

10.6.1 (6.5.1) Information content

10.6.1.1 required information

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode. Apply all static data to the EUT.

Record all messages on VDL and check the contents of position report message 18 and static data report message 24 A and B.

Required results

Confirm that data transmitted by the EUT complies with static data and position sensor data.

10.6.1.2 (6.3, 6.6.3) External sensor information

This test is applicable if an optional interface for external sensors is provided.

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode.

- a) Apply external position data with expected error < 10m (from GBS sentence) and within 26 m of internal position
- b) Simulate unavailable/invalid external sensor data and missing/incorrect checksum
- c) Apply a non-WGS84 or unspecified (no DTM) position input.
- d) Apply a low accuracy position input with expected error > 10m or without RAIM information (no GBS).
- e) Apply position data with more than 26m apart from internal position

Record all messages on VDL and check the contents of position report message 18 for position and COG/SOG.

Required results

- a) Confirm that data transmitted by the EUT complies with external sensor inputs.
- b), c), d), e) Confirm that external data is not used.

Confirm that accuracy and RAIM flags are set accordingly; confirm that position and COG/SOG are of the same source.

10.6.2 (6.5.2) Information update rates**10.6.2.1 (6.5.2) nominal reporting interval****Method of measurement**

Set-up standard test environment and operate EUT in autonomous mode.

- a) start with own SOG of 1kn; record all messages on VDL for 10min and evaluate reporting rate for position report of EUT by calculating average transmission offset over test period.
- b) Increase speed to 10 kn
- c) Reduce speed to 1 kn

Record all messages on VDL and check transmission offset between two consecutive transmissions.

Required results

- a) Reporting interval shall be 3 min (± 10 sec).
- b) Confirm that the reporting interval of 30 sec (± 5 sec) has been established after the next transmission in the old schedule at the latest. The average reporting interval calculated over at least 25 transmissions shall be 30 sec (± 2 sec).
- c) Confirm that the reporting rate is reduced after 3 minutes (speed reduction).

10.6.2.2 (6.5.2) Assigned reporting interval

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode.

- a) Transmit an Assigned mode command message 23 to the EUT with designated reporting intervals of 5sec to 3 min according to Table 17.
- b) Transmit an Assigned mode command message 23 to the EUT with designated reporting interval of 10 min.
- c) Transmit messages 23 with a refresh rate of 1 min with designated reporting intervals of 6 min and 10 min.
- d) Transmit messages 23 designated reporting interval field settings of 11 ... 15
- e) Change course, speed. Record transmitted messages.

Required results

- a) Confirm that the EUT transmits position reports message 18 according to the parameters defined by message 23. The EUT shall revert to autonomous mode with nominal reporting interval after 4 to 8 min.
- b) Confirm that the EUT reverts to autonomous mode with nominal reporting interval after 4 to 8 min.
- c) Confirm that the EUT transmits position reports message 18 according to the parameters defined by message 23
- d) Confirm that the EUT does not change its nominal behaviour
- e) The reporting interval shall not be affected by course or speed.

10.6.2.3 (6.5.2) Static data reporting interval

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode. Record the transmitted messages and check for static data (message 24).

Repeat the test at an assigned reporting interval of 5 sec.

Required results

Confirm that the EUT transmits submessages 24A and 24B every 6 min (24B following 24A within 1 minute). Transmission shall alternate between channels A and B and be independent of the message 18 reporting interval.

10.7 (6.5.3) Initialisation period

Method of measurement

Set up standard test environment with SOG>2 kn.

- a) Switch on the EUT from cold (off-time minimum one hour) with EUT operating in autonomous mode.
 - b) Switch off the EUT for a period of time between 15 to 60 minutes and switch on again.
 - c) Make the GNSS sensor unavailable for a period of time between 1 to 5 minutes
- Record transmitted messages.

Required results

Confirm that the EUT starts regular transmission of message 18 including valid position

- a) within 30 minutes after switch on
- b) within 5 minutes
- c) stops transmitting after the next transmission and resumes within 1 minute after enabling the position source

10.8 (6.6) Alarms and indications, fall-back arrangements**10.8.1 (6.6.1) Built in Integrity test****Method of measurement**

Check manufacturer's documentation on Built in Integrity test.

Required result

Verify that an indication is provided if a malfunction is detected..

10.8.2 (6.6) Transceiver protection**Method of measurement**

Set-up standard test environment and operate EUT in autonomous mode. Open circuit and short circuit VHF-antenna terminals of the EUT for at least 5 min each.

Required results

The EUT shall be operative again within 2 min after refitting the antenna without damage to the transceiver.

10.8.3 (6.6.2) Transmitter shutdown procedure**Method of measurement**

Check manufacturer's documentation on transmitter shutdown procedure.

Required result

Verify that a transmitter shutdown procedure independent of the operating software is provided (see 6.6.2).

10.8.4 (6.6.3) Position sensor fallback conditions**Method of measurement**

Set-up standard test environment and operate EUT in autonomous mode. Where an option for an external GNSS sensor is not provided, then the respective tests shall be omitted.

Apply position sensor data in a way that the EUT operates in the states defined below:

- a) external DGNSS in use if implemented
- b) internal DGNSS in use (corrected by message 17) if implemented
- c) internal DGNSS in use (corrected by a beacon) if implemented

- d) external EPFS in use if implemented
- e) internal GNSS in use
- f) no sensor position in use

Check the position accuracy and RAIM flag in the VDL message 18 and, where provided, the ALR sentence.

Required result

Verify that the use of position source, position accuracy flag, RAIM flag and position information complies with Table 1.

Verify that the position sensor status is maintained for the next scheduled report and changed after that.

10.8.5 (6.6.4) Speed sensors

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode. Where an option for an external GNSS sensor is not provided, this test shall be omitted.

- a) apply valid external DGNSS position and speed data.
- b) make external DGNSS position invalid (e.g. by wrong checksum, "valid/invalid" flag) .

Required Result

- a) Check that the external data for SOG / COG is transmitted in message 18
- b) Check that the internal data for SOG / COG is transmitted in message 18

10.9 (6.7) User Interface

10.9.1 Display

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode.

- a) Check status indications for power, TX timeout, Error
- b) apply message 23 "quiet time" of >7 min
- c) simulate VDL load in order to make it impossible for the EUT to find free candidate periods

Required results

- a) Indicators shall be available and working correctly according to manufacturer's documentation.
- b) check that the TX timeout indication is activated.

10.9.2 Message display

This test is only applicable if a message display is provided.

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode.

Transmit a message 14.

Required results

Verify that the EUT displays the message.

10.9.3 Static data input**Method of measurement**

Verify that static data can be input to the unit according to the manufacturer's documentation. Set-up standard test environment and operate EUT in autonomous mode.

Required results

Check that static data are transmitted correctly by the EUT and that the MMSI can not be altered by the user.

10.9.4 External interfaces**10.9.4.1 Display interface**

This test only applies if a display interface is provided.

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode. Apply to the VDL safety related broadcast message message 14 to the EUT.

Check the output on the display interface.

Required results

The Interface shall be compliant with IEC 61162 series protocol and the manufacturer's documentation of interface hardware.

11 Physical Tests

11.1 TDMA Transmitter

11.1.1 (M1371/A2-2.4.3) Frequency Error

Definition

The frequency error of the transmitter is the difference between the measured carrier frequency in the absence of modulation of the transmitter and its required frequency.

Method of measurement

- a) The carrier frequency shall be measured in the absence of modulation.
- b) Tests shall be performed on the lowest operating frequency on which the EUT can transmit according to the manufacturers specification and AIS2 (162,025 MHz).
- c) The measurement shall be made under normal and extreme test conditions.

Required results

The frequency error shall not exceed ± 0.5 kHz under normal and ± 1 kHz under extreme test conditions.

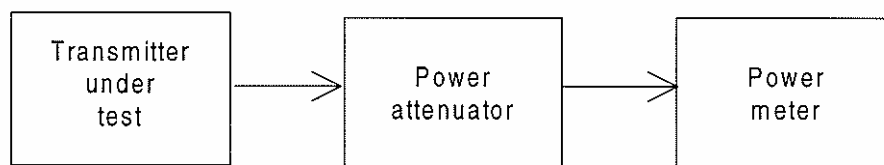
11.1.2 (M1371/A2-2.13.2) Carrier Power

Definition

The power of a radio frequency signal (conducted) is defined as the mean power delivered to a $50\ \Omega$ load during a radio frequency cycle. The Carrier Power (P_c) is defined as the average radio frequency power measured over the transmitter duration. The transmitter duration is defined in section 0.

Method of measurement

Figure 9 - Measurement arrangement for carrier power



- a) The transmitter shall generate test signal number 4.
- b) The average power shall be measured over the transmitter duration. This power shall be further averaged over measurements from 200 transmissions. This value shall be corrected according to the transmitter duty cycle to indicate P_c .
- c) Tests shall be performed on the lowest operating frequency on which the EUT can transmit according to the manufacturers specification and AIS2 (162,025 MHz).
- d) The measurement shall be carried out under normal and extreme test conditions.

Required results

At all test frequencies, the carrier power shall be $31,8 \pm 3$ dBm under normal test conditions.

At all test frequencies the carrier power shall be $31,8 \pm 5$ dBm under extreme test conditions.

11.1.3 Transmission Spectrum

This test is to ensure that the modulation and transient sidebands produced by the transmitter under normal operating conditions fall within the allowable mask.

Method of measurement

- The test shall use test signal number 4.
- The EUT shall be connected to a spectrum analyser. A resolution bandwidth of 1kHz, video bandwidth of 3kHz or greater and positive peak detection (maximum hold) shall be used for this measurement. A sufficient number of sweeps shall be used and sufficient transmission packets measured to ensure that the emission profile is developed.
- Tests shall be performed on the lowest operating frequency on which the EUT can transmit according to the manufacturers specification and AIS2 (162,025MHz).

Required result

The spectrum for slotted transmission shall be within the emission mask as follows:

- In the region between the carrier and ± 10 kHz removed from the carrier, the modulation and transient sidebands shall be below 0 dBc.
- At ± 10 kHz removed from the carrier, the modulation and transient sidebands shall be below -25 dBW.
- At ± 25 kHz to $\pm 62,5$ kHz removed from the carrier, the modulation and transient sidebands shall be below -60 dBW.
- In the region between ± 10 kHz and ± 25 kHz removed from the carrier, the modulation and transient sidebands shall be below a line specified between these two points.

The reference level for the measurement shall be the carrier power (conducted) recorded for the appropriate test frequency in section 11.1.2.

For information the emission mask specified above is shown in Figure 10.

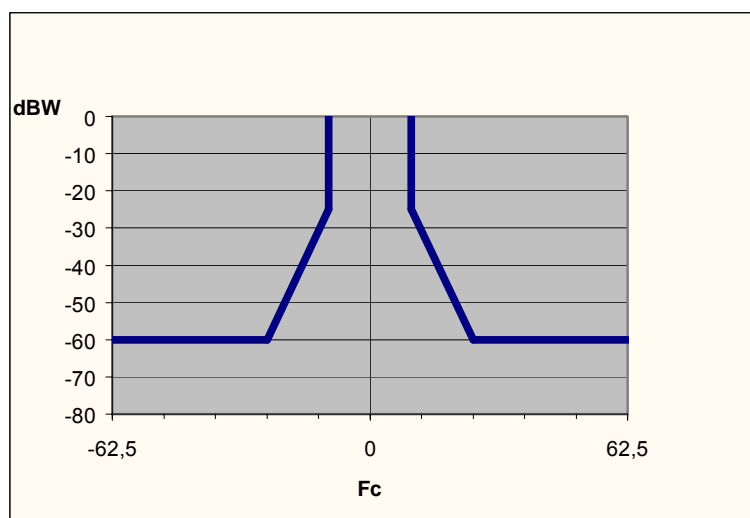


Figure 10 - Modulation spectrum

11.1.4 Modulation Accuracy

Definition

The modulation accuracy is the measurement of the peak frequency deviation of the transmitter modulation and the correct implementation of the GMSK BT filtering.

Method of measurement

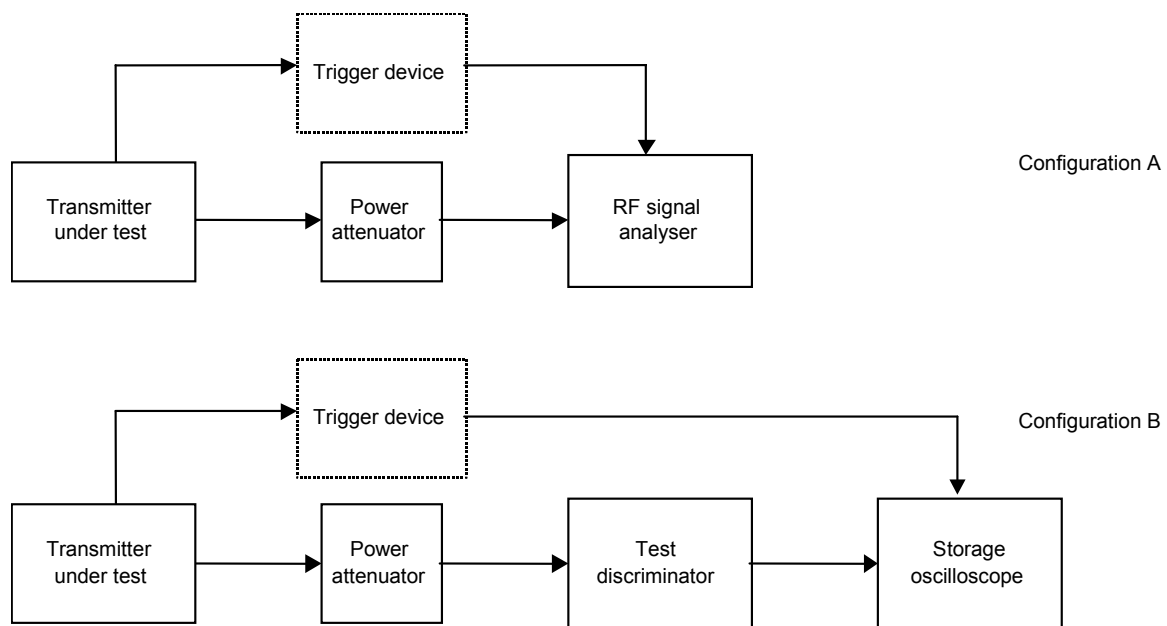


Figure 11 Measurement arrangement for modulation accuracy

The measurement procedure shall be as follows :

- The equipment shall be connected in either configuration A or configuration B as shown. The trigger device is optional if the equipment is capable of synchronising to the transmitted bursts.
- The transmitter shall be tuned to AIS2 (162,025 MHz).
- The transmitter shall be modulated with test signal number 2.
- The deviation from the carrier frequency shall be measured as a function of time.
- The transmitter shall be modulated with test signal number 3.
- The deviation from the carrier frequency shall be measured as a function of time.
- Measurements shall be repeated at the lowest frequency on which the EUT can transmit, according to the manufacturer's specification.
- Testing shall be repeated under extreme test conditions.

Required results

Peak frequency deviation at various points within the data frame shall comply with Table 20. These limits apply to both the positive and negative modulation peaks. Bit 0 is defined as the first bit of the training sequence.

Table 20 - Peak frequency deviation vs. time

Measurement period from centre to centre of each bit	Test signal 2		Test signal 3	
	normal	extreme	normal	Extreme
Bit 0 to bit 1	< 3400 Hz			
Bit 2 to bit 3	2400 ±480 Hz			
Bit 4 to bit 31	2400 ±240 Hz	2400 ±480 Hz	2400 ±240 Hz	2400 ±480 Hz
Bit 32 to bit 199	1740 ±175 Hz	1740 ±350 Hz	2400 ±240 Hz	2400 ±480 Hz

11.1.5 Transmitter output power versus time function

Definition

Transmitter output power versus time function is a combination of the transmitter delay, attack time, release time and transmission duration (referring to Figure 3), where:

- Transmitter delay (T_A) is the time between the start of the candidate transmission time period and the time when the transmission power exceeds -50dBc.
- Transmitter attack time ($T_B - T_A$) is the time between the transmit power exceeding -50dBc and the moment when the transmit power has reached a level 1 dB below the measured steady state power (P_{ss}) and maintains a level within +1,5 / -1dB from P_{ss} thereafter.
- Transmitter release time ($T_F - T_E$) is the time between the end flag being transmitted and the moment when the transmitter output power has reduced to a level 50 dB below P_{ss} and remains below this level thereafter.
- Transmission duration ($T_F - T_A$) is the time from when power exceeds -50 dBc to when the power returns to and stays below -50 dBc.

Method of measurement

- The measurement shall be carried out by transmitting test signal number 2 (note that this test signal generates one additional stuffing bit within its CRC portion).
- The EUT shall be connected to a spectrum analyser. A resolution bandwidth of 1MHz, video bandwidth of 1MHz and a sample detector shall be used for this measurement. The analyser shall be in zero-span mode for this measurement.
- For the purposes of this test the EUT shall be equipped with a test signal (SYNC) indicating the start of each time period that it intends to transmit into. This will be used as a trigger source for the spectrum analyser. The SYNC signal shall be aligned to the nominal start time (T_0) of the transmission time period.
- Tests shall be performed on the lowest operating frequency on which the EUT can transmit according the manufacturers specification and AIS2 (162,025MHz).

Required result

The transmitter power shall remain within the mask shown in Figure 3 and associated timings given in Table 6.

11.2 TDMA Receivers

11.2.1 Sensitivity

Definition

The maximum usable sensitivity is the minimum level of signal (dBm) at the receiver input, produced by a carrier at the nominal frequency of the receiver, modulated with the normal test

signal, which will, without interference, produce after demodulation a data signal with a specified packet error rate (PER).

Method of Measurement

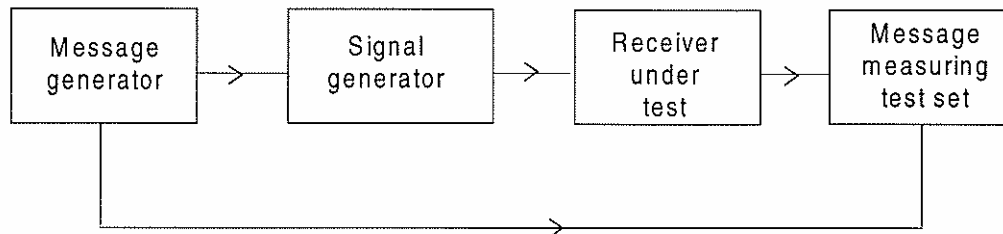


Figure 12 Measurement arrangement

The measurement procedure shall be as follows:

- a) The signal generator shall be at the nominal frequency of the receiver and shall be modulated to generate test signal number 5.
- b) The signal level at the input of the receiver shall be set to -107dBm.
- c) The message measuring test set shall be monitored and the packet error rate observed. The PER shall be derived by the following formula:-

$$PER = (P_{TX} - P_{RX}) / P_{TX} \times 100 (\%)$$

$$P_{RX} = \text{number of packets received without errors.}$$

$$P_{TX} = \text{number of transmitted packets.}$$
- d) The test shall be repeated at the nominal carrier frequency $\pm 500\text{Hz}$ and the level at the input to the receiver adjusted to -104dBm under normal conditions.
- e) The test shall be carried out on the lowest TDMA frequency declared by the manufacturer and AIS2 (162,025 MHz).
- f) Repeat under extreme conditions, at the nominal carrier frequency only. The signal generator shall be adjusted so the level at the input to the receiver is -101dBm.

Required results

The PER shall not exceed 20%.

11.2.2 Error Behaviour at High Input Levels

Definition

The error behaviour (performance) at high input levels (noise free operation) is defined in the same manner as for the measurement of the maximum usable sensitivity when the level of the wanted signal is significantly above the maximum wanted sensitivity.

Method of measurement

The measurement configuration for receiver sensitivity (11.2.1) shall be used.

The signal generator shall be at the nominal frequency of the receiver and shall be modulated to generate test signal number 5. The test shall be carried out on the lowest TDMA frequency declared by the manufacturer and AIS2 (162,025 MHz). The message measuring test set shall be monitored and the packet error rate observed.

- a) The level of the input signal shall be adjusted to a level of -77 dBm;

b) The level of the input signal shall be adjusted to a level of -7 dBm;

Required results

The PER shall not exceed 2% under a) and 10% under b).

11.2.3 Co-Channel Rejection

Definition

The co-channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver.

Method of measurement

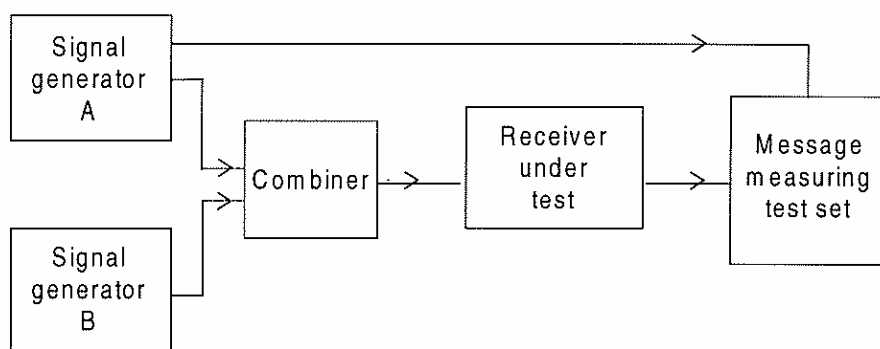


Figure 13 Measurement arrangement with two generators

The measurement procedure shall be as follows:

- Two generators A and B, shall be connected to the receiver via a combining network.
- The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall be modulated to generate test signal number 5.
- The unwanted signal, provided by generator B, shall also be at the nominal frequency of the receiver. Generator B shall be modulated to generate test signal number 4, either continuously or in the same time period as that used by generator A for test signal number 5. The data of the wanted and unwanted signals shall not be synchronised.
- The level of the wanted signal from generator A shall be adjusted to -101dBm.
- The level of the unwanted signal from generator B shall be adjusted to -111dBm.
- The message measuring test set shall be monitored and the packet error rate (PER) observed.
- The measurement shall be repeated for displacements of the unwanted signal of ± 1 kHz¹² from the nominal frequency of the receiver and the PER again observed.
- The test shall be carried out on the lowest TDMA frequency declared by the manufacturer and AIS2 (162,025 MHz).

Required result

The PER shall not exceed 20%.

¹² which is twice the allowable transmit frequency tolerance

11.2.4 Adjacent Channel selectivity

Definition

The adjacent channel selectivity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended.

Method of measurement

The measurement procedure shall be as follows:

- a) The measurement configuration for co-channel rejection (11.2.3) shall be used.
- b) The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall be modulated to generate test signal number 5.
- c) The unwanted signal, provided by generator B, shall be frequency modulated with a 400Hz sine wave giving a deviation of $\pm 3\text{kHz}$. Generator B shall be at a frequency 25kHz above that of the wanted signal.
- d) The level of the wanted signal from generator A shall be adjusted to a level of -101dBm.
- e) The level of the unwanted signal from generator B shall be adjusted to -31dBm.
- f) The message measuring test set shall be monitored and the packet error rate observed.
- g) Repeat the above measurement with the unwanted signal 25kHz below the wanted signal.
- h) The test shall be carried out on the lowest TDMA frequency declared by the manufacturer and AIS2 (162,025 MHz).

Required result

The PER shall not exceed 20%.

11.2.5 Spurious Response Rejection

Definition

The spurious response rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal at any other frequency, at which a response is obtained.

Manufacturers' declarations

The manufacturer shall declare the following in order to calculate the "Limited Frequency Range" over which the initial part of the test will be performed:

List of intermediate frequencies: IF₁, IF₂, ...IF_N in Hz

Switching range of the receiver¹³: sr

Frequency of the local oscillator¹⁴ at AIS2 and at the lowest TDMA channel: f_{LOH} , f_{LOL}

Introduction to the method of measurement

¹³ Switching range corresponds to the frequency range over which the receiver can be tuned.

¹⁴ This may be a VCO, crystal, sampling clock, BFO, Numerically Controlled Oscillator depending on the design of the equipment.

The initial evaluation of the unit shall be performed over the "Limited Frequency Range" and shall then be performed at the frequencies identified from this test and at "Specific Frequencies of Interest" (as defined below).

To determine the frequencies at which spurious responses can occur the following calculations shall be made:

a) Calculation of the "Limited Frequency Range":

The limits of the limited frequency range (LFR_{HI} LFR_{LO}) are determined from the following calculations:

$$LFR_{HI} = f_{LOH} + (IF_1 + IF_2 + \dots + IF_N + sr/2)$$

$$LFR_{LO} = f_{LOL} - (IF_1 + IF_2 + \dots + IF_N + sr/2)$$

b) Calculation of Specific Frequencies of Interest (SFI) outside the limited frequency range:

These are determined by the following calculations:

$$SFI_1 = (K * f_{LOH}) + IF_1$$

$$SFI_2 = (K * f_{LOL}) - IF_1$$

where K is an integer from 2 to 4.

Method of Measurement over the Limited Frequency Range

Two methods are available for the measurements over the Limited Frequency Range, one based on SINAD measurements (A) and the other based on PER measurements (B). Either method may be used, but in each case shall be followed by the Method of Measurement at Identified Frequencies.

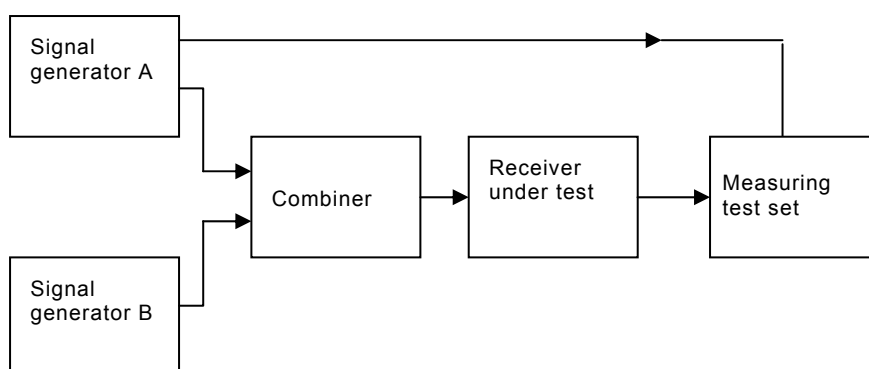


Figure 14 PER/BER or SINAD Measuring Equipment

A) Method of search over the "Limited Frequency Range" using SINAD measurement

a) Two generators A and B shall be connected to the receiver via a combining network.

The wanted signal, provided by generator A, shall be at the nominal frequency of the receiver and shall be modulated with 1kHz sine wave at ± 2.4 kHz deviation.

The unwanted signal, provided by generator B, shall be frequency modulated with a 400Hz sine wave giving a deviation of ± 3 kHz.

- b) Initially, generator B (unwanted) shall be switched off (maintaining the output impedance).
The signal level from generator A (wanted) shall be adjusted to -101dBm at the receiver.
The SINAD value shall be noted (and should be greater than 14dB)
- c) Signal generator B shall be switched on and adjusted to -27dBm at the receiver.
- d) The frequency of the unwanted signal shall be varied in steps of 5kHz over the Limited Frequency Range (from LFR_{LO} to LFR_{HI}).
- e) The frequency of any spurious response detected (by an decrease in SINAD of 3dB or more) during the search shall be recorded for use in the next measurements.

B) Method of search over the "Limited Frequency Range" using PER or BER measurement

- a) Two generators A and B, shall be connected to the receiver via a combining network.
The wanted signal, provided by generator A, shall be at the nominal frequency of the receiver and shall be modulated to generate test signal number 5.
The unwanted signal, provided by generator B, shall be frequency modulated with a 400Hz sine wave giving a deviation of ± 3 kHz.
- b) Initially, generator B (unwanted) shall be switched off (maintaining the output impedance).
The signal level from generator A (wanted) shall be adjusted to -101dBm at the receiver.
The PER or BER shall be noted
- c) Signal generator B shall be switched on and adjusted to -27dBm at the receiver.
- d) The frequency of the unwanted signal shall be varied in steps of 5kHz over the Limited Frequency Range (from LFR_{LO} to LFR_{HI})
- e) The frequency of any spurious response detected (by an increase in either PER or BER) during the search shall be recorded for use in the next measurements.
- f) In the case where operation using a continuous packet stream is not possible a similar method may be used.

Method of measurement (at identified frequencies)

- a) Two generators A and B, shall be connected to the receiver via a combining network.
The wanted signal, provided by generator A, shall be at the nominal frequency of the receiver and shall be modulated to generate test signal number 5.
The unwanted signal, provided by generator B, shall be frequency modulated with a 400Hz sine wave giving a deviation of ± 3 kHz. Generator B shall be at the frequency of that spurious response being considered.
- b) Initially, generator B (unwanted) shall be switched off (maintaining the output impedance).
The signal level from generator A (wanted) shall be adjusted -101dBm at the receiver.
- c) Generator B shall be switched on, and the level of the unwanted signal set to -31dBm
- d) For each frequency noted during the tests over the Limited Frequency Range and the Specific Frequencies of Interest (SFI_1 and SFI_2), transmit 200 packets to the EUT and note the PER.

Required Results

At any frequency separated from the nominal frequency of the receiver by two channels or more, the spurious responses shall not result in a PER of greater than 20%.

11.2.6 Intermodulation response rejection

Definition

The intermodulation response rejection is the capability of the receiver to receive a wanted modulated signal, without exceeding a given degradation due to the presence of two close-spaced unwanted signals with a specific frequency relationship to the wanted signal frequency.

Method of test

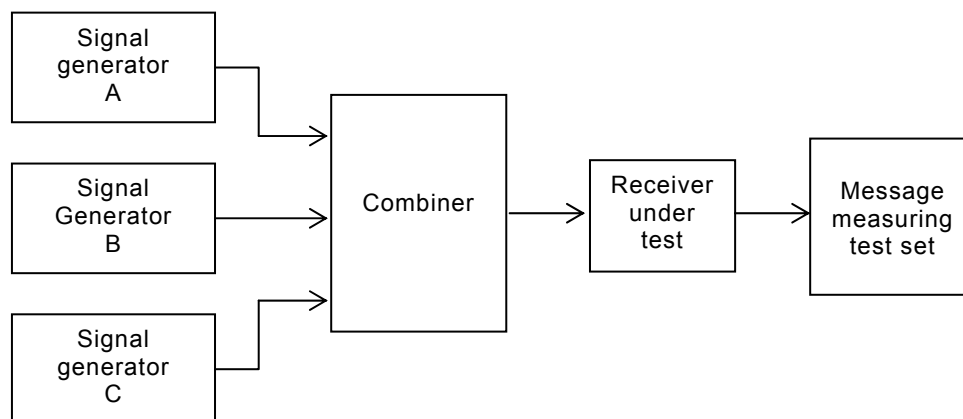


Figure 15 - Measurement arrangement for inter-modulation

The measurement procedure shall be as follows:

- Three signal generators shall be connected to the receiver via a combining network.
- The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall be modulated to generate test signal number 5.
- The unwanted signal from generator B shall be unmodulated.
- The unwanted signal from generator C shall be frequency modulated with a 400Hz sine wave giving a deviation of $\pm 3\text{kHz}$.
- The signal level from generator A (wanted) shall be set for -101dBm at the receiver input.
- The signal level from generators B and C shall be set for -36dBm at the receiver input.
- The frequencies of generators A, B, C shall be set as per test #1 of Table 21.
- The message measuring test set shall be monitored and the packet error rate observed.
- Repeat the measurement with frequencies set as per test #2, #3 and #4 of Table 21.

	Generator A Wanted AIS Signal	Generator B Unmodulated (+/-50kHz)	Generator C Modulated (+/-100kHz)
Test #1	162,025MHz	162,075MHz	162,125MHz
Test #2	162,025MHz	161,975MHz	161,925MHz
Test #3	F_{TDMAIo}	$F_{\text{TDMAIo}} + 50\text{kHz}$	$F_{\text{TDMAIo}} + 100\text{kHz}$
Test #4	F_{TDMAIo}	$F_{\text{TDMAIo}} - 50\text{kHz}$	$F_{\text{TDMAIo}} - 100\text{kHz}$

Table 21 - Frequencies for inter-modulation test

Note: F_{TDMAIo} is the lowest frequency on which the EUT can operate according the manufacturers specification

Required results

The PER shall not exceed 20%.

11.2.7 Blocking or Desensitisation

Definition

Blocking is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted input signal at any frequencies other than those of the spurious responses or the adjacent channels.

Method of measurement

The measurement procedure shall be as follows:

- Two generators A and B, shall be connected to the receiver via a combining network.
- The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall be modulated to generate test signal number 5.
- The unwanted signal from generator B shall be unmodulated and shall be at a frequency 0.5 to 10 MHz away from the nominal frequency of the receiver. Measurements shall be carried out at frequencies of the unwanted signal at approximately $\pm 500\text{kHz}$, $\pm 1\text{MHz}$, $\pm 2\text{MHz}$, $\pm 5\text{MHz}$ and $\pm 10\text{MHz}$, avoiding those frequencies at which spurious responses could occur (sub-clause A.4.5).
- Initially, signal generator B (unwanted signal) shall be switched off (maintaining the output impedance). The level of the wanted signal from generator A shall be adjusted to -101dBm at the receiver input.
- The RF signal level for signal generator B (unwanted signal) shall be adjusted to -23 dBm when the frequency setting is less than $\pm 5\text{MHz}$. For frequency settings of $\pm 5\text{MHz}$ or higher the RF level shall be adjusted to -15 dBm.
- The test shall be repeated for all the frequencies defined in step c).
- The test shall be carried out on the lowest frequency on which the EUT can operate according the manufacturers specification and AIS2 (162,025 MHz).

Required results

The maximum packet error rate shall not exceed 20%.

11.3 Conducted spurious emissions

11.3.1 (ITU-R M.489-2) Spurious Emissions from the Receiver

Definition

Spurious emissions from the receiver are components at any frequency, conducted to the antenna. The level of spurious emissions shall be measured as their power level in a specified load.

Method of Measurement

The receiver shall be connected to a 50 Ω attenuator. The output of the attenuator shall be connected to a spectrum analyser or selective voltmeter having an input impedance of 50 Ω . If the detecting device is not calibrated in terms of power input, the level of any detected components shall be determined by a substitution method using a signal generator. The measurement shall extend over the frequency range 9 kHz to 4 GHz.

The receiver shall be switched on, and the measuring receiver shall be tuned over the frequency range 9 kHz to 4 GHz.

At each frequency at which a spurious component is detected, the power level shall be recorded as the spurious level delivered into the specified load.

Results Required

The power of any spurious emission in the specified range at the antenna terminal shall not exceed -57 dBm (2 nW) in the frequency range 9 kHz to 1 GHz and -47 dBm (20 nW) in the frequency range 1 GHz to 4 GHz.

11.3.2 (ITU-R M.489-2) Spurious emissions from the transmitter

Definition

Conducted spurious emissions are emissions on a frequency or frequencies, which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.

Method of Measurement

The transmitter shall be connected to a 50 Ω power attenuator. The output of the power attenuator shall be connected to a measuring receiver.

If possible, the measurement shall be made with the transmitter unmodulated. If this is not possible, the transmitter shall be modulated by test signal number 4. If possible the modulation should be continuous for the duration of the measurement.

The measurement shall be made over a frequency range from 9 kHz to 4 GHz, excluding the channel on which the transmitter is operating and its adjacent channels.

The resolution bandwidth of the measuring instrument shall be the smallest bandwidth available which is greater than the spectral width of the spurious component being measured. This shall be considered to be achieved when the next highest bandwidth causes less than 1 dB increase in amplitude. Positive peak detection (maximum hold) shall be selected on the spectrum analyser used for this measurement.

A sufficient number of sweeps shall be measured to ensure that the emission profile is developed.

At each frequency at which a spurious component is detected, the power level shall be recorded as the conducted spurious emission level delivered into the specified load, except for the channel on which the transmitter is intended to operate and the adjacent channels.

The conditions used in the relevant measurements shall be recorded in test reports.

Results Required

The power of any spurious emission on any discrete frequency shall not exceed 0,25 μW (-36 dBm) in the frequency range 9 kHz to 1 GHz and 1 μW (-30 dBm) in the frequency range 1 GHz to 4 GHz.

12 (7.3) Specific tests of Link Layer

12.1 TDMA Synchronisation

12.1.1 Synchronisation test sync mode 1

Definition

Synchronisation jitter (transmission timing error) is the time between nominal start of the transmission time period as determined by a UTC synchronisation source ($T_{o, ref}$) and T_o of the EUT ($T_{o, EUT}$).

Method of measurement

Set up standard test environment; set EUT to assigned mode for a reporting rate of 5 sec; chose test conditions in a way that the EUT operates in following synchronisation modes:

- station transmitting message 1 or 2, 3, 4, 18, 19 not subject to a CS-delay, with repeat indicator = 0 and with position available is received by the EUT
- switch off sync source
- wait until internal clock of EUT is out of sync (sync jitter > 1000 μ s); transmit messages not to be used as sync source (see 7.3.1.1) to the EUT
- repeat test a) using a sync source transmitting message 1; simulate the position of the station providing the sync source (e.g. 120 NM = 741 μ s away from EUT position) in order to simulate a propagation delay.

Record VDL messages and measure the time between $T_{o, ref}$ of the synchronisation source and the initiation of the "transmitter on" function T_A and calculate back to $T_{o, EUT}$ (a sync output may be used for the purpose of this test). Alternative methods, e.g. by evaluating the start flag are allowed.

Required results

- The EUT shall synchronise on the received source and the synchronisation jitter shall not exceed $\pm 312 \mu$ s (sync mode 1).
- The synchronisation jitter shall not exceed $\pm 312 \mu$ s during a 30 sec period from the time a proper sync source was last received.
- The EUT shall not synchronise on these received messages.
- The synchronisation jitter of the EUT shall be within -741μ s $\pm 312 \mu$ s .

12.1.2 Synchronisation test sync mode 2

Method of measurement

Set up standard test environment; choose test conditions in a way that the EUT operates in following synchronisation modes:

- operate EUT in sync mode 2 for more than 5 min.

- b) Switch on sync source immediately after scheduled transmission of EUT. Sync source shall be a station transmitting message 1 or 2,3,4,18,19 not subject to a CS-delay, with repeat indicator = 0 and with position available with a reporting rate of 10 sec.

Record VDL messages and measure the time between $T_{o\ ref}$ of the synchronisation source and the initiation of the "transmitter on" function T_A and calculate back to $T_{o\ EUT}$ (a sync output may be used for the purpose of this test). Alternative methods, e.g. by evaluating the start flag are allowed.

Required result

Verify that the EUT synchronises its next scheduled transmission on the sync source. The synchronisation jitter shall not exceed $\pm 312\ \mu\text{s}$.

12.1.3 Synchronisation test with UTC

This test is only relevant if optional synchronisation sources providing UTC are implemented.

Method of measurement

Set up standard test environment; choose test conditions in a way that EUT operates in UTC synchronised mode

Required results

The synchronisation jitter shall not exceed $\pm 312\ \mu\text{s}$.

12.2 Carrier sense threshold

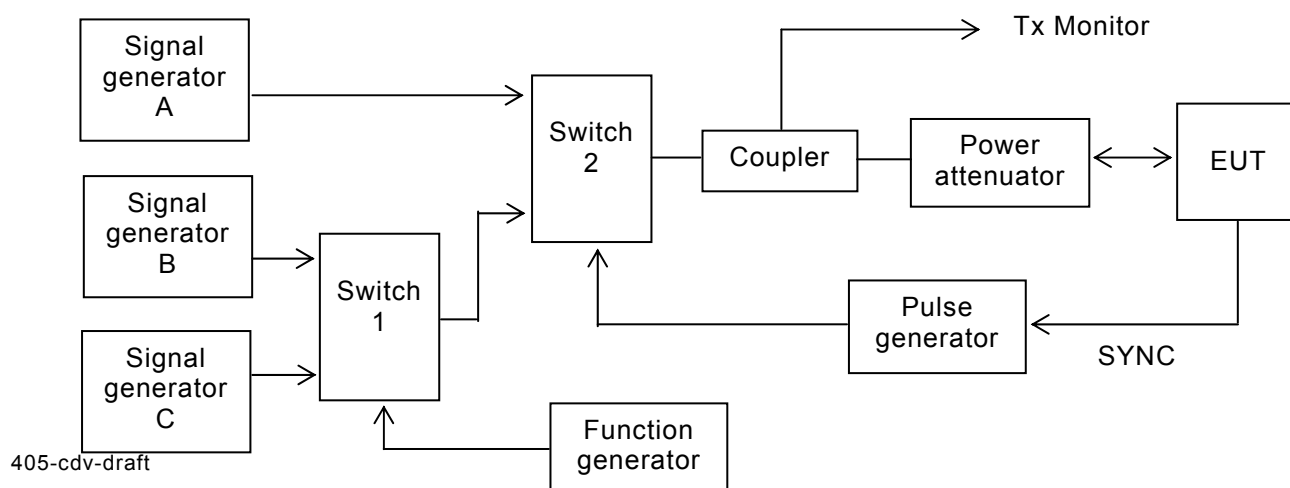
Definition

Carrier sense threshold is the signal level below which a time period shall be regarded as unused and a transmission may take place.

Method of measurement

The test configuration is described here in its most basic form, using three signal sources with RF (PIN) switches selecting when each signal is applied to the EUT. Other equipment configurations may be used if they fulfil the same requirements (for example a single RF source fed via a switched attenuator, which is controlled by a timing circuit).

Figure 16 Configuration for carrier sense threshold test



- a) Signal C is an unmodulated carrier equivalent to -60 dBm at the EUT. The switches connect this signal to the EUT most of the time to mimic 100% channel loading with strong traffic.
- b) Signal B is an unmodulated carrier equivalent to -87 dBm at the EUT. Switch 1 replaces signal C with signal B for 26,67 ms. The function generator makes this happen once every 2 seconds. This imitates one vacant time period in a 99% loaded channel. The level of Signal B can be manually switched between -87dBm and OFF to mimic high and low background levels.
- c) Signal A is an unmodulated carrier equivalent to -104 dBm at the EUT. When the EUT attempts a transmission, switch 2 replaces the 'background traffic' with signal A to imitate an incoming message intended to inhibit the transmission attempt. The level of signal A can be manually set to -74 dBm, -104 dBm and OFF (defined as less than -117 dBm).
- d) All three signal generators are tuned to the same frequency. The test shall be carried out on the lowest frequency declared by the manufacturer and AIS2 (162,025 MHz).
- e) For the purposes of this test the EUT will be equipped with a test signal (SYNC) indicating the start of each time period that it intends to transmit into. This is used to trigger the pulse generator which after a delay of 0,8 ms (8 bits) generates a 23,3 ms (224 bits) pulse for switch 2.
- f) With the signal levels set to the levels shown in the first row of the following table, the EUT shall be observed making routine scheduled position reports. Levels shall then be adjusted as per subsequent rows and the EUT monitored for 10 minutes (or at least 20 reporting attempts) to confirm if transmission has ceased.

Required results

Table 22 Required threshold test results

Step	Description	Signal A (dBm)	Signal B (dBm)	EUT transmission
1	Time period free	OFF	OFF	Yes
2	Time period used	-104	OFF	Ceased
3	Recovery	OFF	OFF	Yes
4	Raised background	OFF	-87	Yes
5	Time period used	-74	-87	Ceased
6	Recovery	OFF	-87	Yes

12.3 VDL state / reservations

Method of measurement

Set-up standard test environment and operate EUT with assigned reporting interval of 10sec. Record transmitted scheduled position reports message 18 and check time periods used for transmission.

- a) Transmit a message 20 to the EUT reserving a block of time periods including timeout.
- b) Transmit a message 20 to the EUT reserving a block of time periods without timeout.

Required results

- a) verify that the reserved block is not used and used again after the timeout specified in message 20

b) verify that the reserved block is not used and used again after a timeout of 3 min.

12.4 Data encoding (bit stuffing)

Method of measurement

Setup standard test environment.

Set ships name to HEX-Values “7E 3B 3C 3E 7E” so that bit-stuffing will be applied and check the VDL (note that this might require that the manufacturer provides means to input this data).

Required results

Confirm that transmitted VDL message 24 conforms to data input.

12.5 Frame check sequence

Method of measurement

Apply simulated position report messages with wrong CRC bit sequence to the VDL.

- a) Check test output; if a display interface is provided, check this.
- b) Repeat test 12.1.1 and check that a station transmitting messages with wrong CRC are not used for synchronisation.

Required results

Confirm that messages with invalid CRC are not accepted by the EUT in cases a) and b).

12.6 Slot allocation (Channel access protocol)

12.6.1 Autonomous mode allocation

Method of measurement

Set-up standard test environment and operate EUT with assigned reporting interval of 10sec. Record transmitted scheduled position reports message 18 and check time periods used for transmission. Check CommState of transmitted messages.

Repeat the test with additional simulated channel load of 80% (4 time periods used, 1 time period unused).

Required results

The time periods used for transmission shall in both tests

- not exceed the transmission interval TI
- not always use the same time period
- not always use the first unused time period.

Check that the CommState of message 18 is the default value as defined in 7.3.3.5.

12.6.2 DSC listening periods

Method of measurement

This test is applicable only if DSC functionality is implemented.

Set-up standard test environment and operate EUT with assigned reporting interval of 10sec. Enable DSC functionality. Record transmitted scheduled position reports message 18 and check time periods used for transmission.

Required results

During the DSC monitoring times, scheduled transmissions of message 18 shall continue.

12.7 Assigned operation

12.7.1 Assignment priority

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode. Transmit an Assigned mode command (message 23) to the EUT with TX/RX mode 1.

a) Transmit a message 22 defining a region with the EUT inside that region. Transmit a message 22 to the EUT individually addressed and specifying TX/RX mode 2

b) Repeat the test, clear the region defined by message 22 under a) ¹⁵. Transmit Message 22 to the EUT with regional settings specifying TX/RX mode 2

Record transmitted messages.

Required results

a) the Tx/Rx mode field setting of Message 22 shall take precedence over the Tx/Rx mode field setting of Message 23.

b) the Tx/Rx mode field setting of Message 23 shall take precedence over the Tx/Rx mode field setting of Message 22. The receiving station shall revert to its previous Tx/Rx mode after a timeout value randomly chosen between 240 sec and 480 sec.

12.7.2 Entering rate assignment

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode. Transmit a Group Assignment command (message 23) to the EUT with a reporting interval of 10 sec assigned, monitor the VDL, reset by assigning 30sec rate; repeat 10 times.

Required result

Verify that the first transmission after receiving the message 23 is within a time randomly selected between the time the message 23 has been received and the assigned interval.

12.7.3 Reverting from rate assignment

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode. Transmit a Group Assignment command (message 23) to the EUT with a reporting interval of 10 sec assigned,

¹⁵ This can be carried out using the method used in 13.3.1 b) step2 or by assigning a new simulated position to the EUT

monitor the VDL until at least 1 minute after timeout occurred; repeat 10 times (transmissions of message 23 shall not be synchronised to the initial transmission schedule of the EUT).

Measure the time T_{rev} between the reception of message 23 and first transmission after timeout.

Required result

T_{rev} shall be randomly distributed between 240 sec and 480 sec.

12.7.4 Reverting from quiet mode

Method of measurement

Set-up standard test environment and operate EUT with a reporting interval of 10 sec assigned. Transmit a Group Assignment command (message 23) to the EUT with quiet time = 1 min.

Required result

Verify that the first transmission after the quiet period is within the schedule in place before the quiet period.

12.7.5 Retry of interrogation response

Method of measurement

Set-up standard test environment. Interrogate the EUT by message 15 for a response with message 18.

a) Simulate full VDL load for the following 30 sec.

b) Simulate full VDL load for the following 60 sec

Required result

a) Verify that a response is transmitted between 30 and 60 sec after the transmission of message 15.

b) Verify that no response is transmitted.

12.8 Message Formats

12.8.1 Received messages

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode. Apply messages according to Table 11 to the VDL. Record messages output by the PI of EUT where provided.

Required results

Confirm that EUT responds as appropriate. Check that EUT outputs the corresponding sentences with correct field contents and format via the PI where provided.

Verify that the EUT does not process addressed messages.

12.8.2 Transmitted messages

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode. Initiate the transmission of messages relevant for a Class B mobile station according to Table 11 by the EUT. Record transmitted messages.

Required results

Confirm that only messages as allowed by Table 11 are transmitted by the EUT.

12.8.3 (7.3.3.7) Use of safety related message message 14

This test is only applicable if message 14 is implemented

Method of measurement

Check manufacturer's documentation.

- a) Initiate transmission of message 14 as specified by the manufacturer.
- b) Repeat initiation twice a minute

Required results

- a) Verify that the data content of message 14 is predefined and the transmission can not exceed one time period (see Table 12).
- b) Verify that the EUT only accepts the initiation of a message 14 once a minute without automatic repetition.

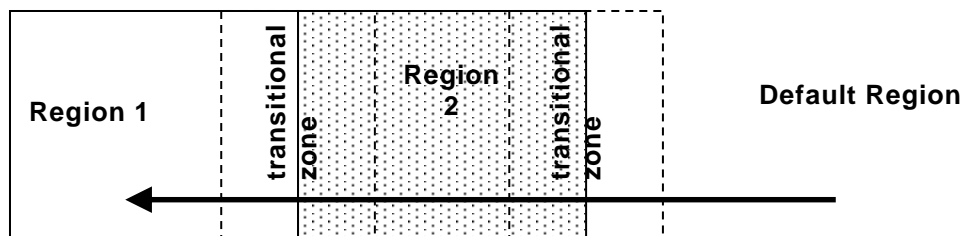
13 Specific tests of Network Layer

13.1 Regional area designation by VDL message

Method of measurement

Set-up standard test environment. Apply Channel management messages (message 22) to the VDL defining two adjacent regional areas 1 and 2 with different channel assignments for both regions and a transitional zone extending 4 NM either side of the regional boundary

Let the EUT approach region 1 from outside region 2 more than 5 NM away from region boundary transmitting on default channels. Record transmitted messages on all 6 channels. This can be accomplished by either using a dedicated test input for simulated position information or a GNSS simulator.



	primary channel	secondary channel
region 1	CH A 1	CH B 1
region 2	CH A 2	CH B 2
default region	AIS 1	AIS 2

Figure 17 Regional area scenario

Required results

Check that the EUT transmits and receives on the primary channels assigned for each region alternating channels and doubling reporting rate when passing through the transitional zones (see Table 23). EUT shall revert to default autonomous operation on the regional channels after leaving the transitional zones.

Table 23 Required channels in use

	Area	Channels in use
1	Default region	AIS1, AIS2
2	First transitional zone	AIS1, CH A 2
3	Region 2	CH A 2, CH B 2
4	Second transitional zone	CH A 2, CH A 1
5	Region 1	CH A 1, CH B 1

13.2 regional area designation by serial message or manually

Method of measurement

Check documentation

Required result

Verify that the user cannot allocate channels (directly or by ACA sentence).

13.3 Management of received regional operating settings

13.3.1 Replacement or erasure of dated or remote regional operating settings

Method of measurement

Set-up standard test environment. Send a valid regional operating setting to the EUT by message 22 with the regional operating area including the own position of the EUT. Consecutively send a total of seven (7) valid regional operating settings to EUT, using message 22, with regional operating areas not overlapping to the first and to each other. Perform the following in the order shown:

- a) Send a ninth message 22 to the EUT with valid regional operating areas not overlapping with the previous eight regional operating areas.
- b) Step 1: Set own position of EUT into any of the regional operating areas defined by the second to the ninth message 22 sent to the EUT previously.
Step 2: Send a tenth message 22 to the EUT, with a regional operating area which partly overlaps the regional operating area to which the EUT was set by Step 1 but which does not include the own position of the EUT.
- c) Step 1: Move own position of EUT to a distance of more than 500 miles from all regions defined by previous commands.
Step 2: Consecutively set own position of EUT to within all regions defined by the previous message 22.

This test can be accomplished by either using the test input for simulated position information or a GNSS simulator (see also Annex B).

Required results

After the initialisation, the EUT shall operate according to the regional operating settings defined by the first message 22 sent.

- a) The EUT shall return to the default operating settings.
- b) Step 1: Check that the EUT changes its operating settings to those of that region which includes own position of the EUT.
Step 2: Check that the EUT reverts to the default operating settings.
Note: Since the regional operating settings to which the EUT was set in Step 1 shall be erased due to Step 2, and since there is no other regional operating setting due to their non-overlapping definition, the EUT shall return to default.
- c) Step 1: Check that the EUT operates with the default settings.
Step 2: Check that the EUT operates with the default settings.

13.3.2 Channel management by addressed message 22

Method of measurement

Set-up a standard test environment and operate EUT in autonomous mode. Perform the following tests in the following order:

- a) Send message 22 with valid regional operating settings that are different from the default operating settings to the EUT with a regional operating area, which contains the current position of own station.
- b) Send an addressed message 22 to the EUT with different regional operating settings than the previous command.
- c) Move the EUT out of the regional operating area defined by the previous addressed command into an area without regional operating settings.

Required results

- a) Check, that the EUT uses the regional operating settings commanded to it in a).
- b) Check, that the EUT uses the regional operating settings commanded to it in b).
- c) Check, that the EUT reverts to default.

13.3.3 Invalid regional operating areas

This test is to check the rejection of invalid regional operating areas (three regional operating areas with same corner).

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode. Perform the following tests in the following order after completion of all other tests related to change of regional operating settings:

- a) Send three different valid regional operating settings with adjacent regional operating areas, their corners within eight miles of each other, to the EUT by message 22. The current own position of the EUT shall be within the regional operating area of the third regional operating setting.
- b) Move current own position of the EUT consecutively to the regional operating areas of the first two valid regional operating settings.

Required test results

- a) Check, that the EUT uses the operating settings that were in use prior to receiving the third regional operating setting.
- b) Check, that the EUT consecutively uses the regional operating settings of the first two received regional operating areas.

13.3.4 Continuation of autonomous mode reporting rate

Method of test

When in the presence of an assigned mode command and in a transition zone, check that the EUT continues to report at the autonomous mode reporting interval.

Required result

Ensure that the autonomous reporting interval is maintained.

13.3.5 Other conditions

The fulfilment of all other conditions of 7.4.2 shall be self-certified by the manufacturer.

14 External interfaces

If an interface is implemented, applicable test procedures of IEC 61993-2 shall be used. The manufacturer shall provide sufficient technical documentation of the EUT and its interfaces in particular.

Annex A (normative)

DSC Channel Management

A.1 DSC Functionality

The AIS shall be capable of performing regional channel designation and regional area designation as defined in ITU-R M.1371-1 Annex 3; DSC transmissions (acknowledgements or responses) shall not be broadcast.

The DSC functionality shall be accomplished by using a dedicated DSC receiver or by time sharing the TDMA channels. The primary use of this feature is to receive channel management messages when AIS 1 and/or AIS 2 are not available.

A.2 DSC time sharing

In the case of equipment which implement the DSC receive function by time sharing the TDMA receive channels, the following shall be observed.

One of the receive processes shall monitor DSC channel 70 for the 30-second time periods in Table A.1. This selection shall not be swapped between the two receive processes.

If the AIS is utilising this time sharing method to receive DSC, AIS transmissions shall still be performed during this period. In order to accomplish the CS algorithm, the AIS receivers' channel switching time shall be such that the DSC monitoring is not interrupted for more than 0,5 sec per AIS transmission.¹⁶

If a DSC command is received, the AIS transmission may be delayed accordingly.

These periods shall be programmed into the unit during its configuration. Unless some other monitoring schedule is defined by a competent authority, the default monitoring times in Table A-1 shall be used. The monitoring schedule shall be programmed into the unit during initial configuration. During the DSC monitoring times, scheduled autonomous or assigned transmissions, and responses to interrogations shall continue.

The AIS device shall be capable of processing message type 104 with expansion symbols No. 00, 01, 09, 10, 11, 12, and 13 of Table 5 of Recommendation ITU-R M.825 (DSC Channel Management test signal number 1 for this test) by performing operations in accordance with ITU-R M.1371-1 Annex 2, § 4.1 with the regional frequencies and regional boundaries specified by these calls.

¹⁶ During the DSC monitoring periods, TDMA receptions will necessarily be disrupted due to this time sharing of the AIS receiver. Proper performance of the AIS assumes that DSC Channel Management messages are transmitted in compliance with Recommendation ITU-R M.825 which requires duplicate messages with a gap of 0.5 second between the two transmissions. This will insure that the AIS can receive at least one DSC Channel Management message during each DSC monitoring time without any affects to its AIS transmit performance.

Table A.1 DSC monitoring times

Minutes past UTC hour
05:30 – 05:59
06:30 – 06:59
20:30 – 20:59
21:30 – 21:59
35:30 – 35:59
36:30 – 36:59
50:30 – 50:59
51:30 – 51:59

Note: Refer to ITU-R M.1371-1, Annex 3, 1.2

For test purposes, the unit may be placed into a mode, which monitors DSC every minute. Entry to this mode shall not be available to the end-user.

Means shall be provided to disable DSC monitoring during setup.

A.3 DSC Functionality Tests

A.3.1 General

(M.1371-1 A3/1)

For the tests in this clause (see also IEC 61993-1), set the EUT into assigned mode using channels AIS1 and AIS2 with a reporting interval of 10 sec.

Check with a sequence of valid calls consisting of a DSC Channel Management test signal number 1, a geographic call from ITU-R M.493, a test signal number 1, an individual call from ITU-R M.493 and a test signal number 1 that the EUT AIS operation is not affected by the interleaved calls.

A.3.2 Regional area designation

(M.1371-1 A3/5)

Perform the following tests using the DSC Channel Management test signal number 1.

Send to the EUT a standard test signal number 1 but with symbol numbers appropriate to the geographical regions and channels specified in the test. Note the transition boundary is 5 NM in this test.

A.3.3 Scheduling

(M.1371-1 A3/2)

Check that the EUT's AIS reporting is not affected during the DSC monitoring times.

Send a valid geographical call to the EUT. Check that a response is not transmitted.

A.3.4 DSC flag in message 18

Check that the DSC flag is set properly when DSC functionality is available.

A.3.5 DSC monitoring time plan

Check that DSC commands are received during DSC monitoring times and, if time-sharing is used, are not received outside those times.

A.3.6 Replacement or erasure of dated or remote regional operating settings

Method of measurement

Set-up standard test environment. Send a valid regional operating setting to the EUT by message 22 with the regional operating area including the own position of the EUT. Consecutively send a total of seven (7) valid regional operating settings to EUT, using both message 22 and DSC telecommands, with regional operating areas not overlapping to the first and to each other. Perform the following in the order shown:

- a) Send a ninth message 22 to the EUT with valid regional operating areas not overlapping with the previous eight regional operating areas.
- b) Step 1: Set own position of EUT into any of the regional operating areas defined by the second to the ninth telecommands sent to the EUT previously.
Step 2: Send a tenth telecommand to the EUT, with a regional operating area which partly overlaps the regional operating area to which the EUT was set by Step 1 but which does not include the own position of the EUT.
- c) Step 1: Move own position of EUT to a distance of more than 500 NM from all regions defined by previous commands.
Step 2: Consecutively set own position of EUT to within all regions defined by the previous telecommands.

Required results

After the initialisation, the EUT shall operate according to the regional operating settings defined by the first message 22 sent.

- a) The EUT shall return to the default operating settings.
- b) Step 1: Check that the EUT changes its operating settings to those of that region which includes own position of the EUT.
Step 2: Check that the EUT reverts to the default operating settings.
Note: Since the regional operating settings to which the EUT was set in Step 1 shall be erased due to Step 2, and since there is no other regional operating setting due to their non-overlapping definition, the EUT shall return to default.
- c) Step 1: Check that the EUT operates with the default settings.
Step 2: Check that the EUT operates with the default settings.

A.3.7 Test of addressed telecommand

Method of measurement

Set-up a standard test environment and operate EUT in autonomous mode. Perform the following tests in the following order:

- a) Send a DSC telecommand with valid regional operating settings that are different from the default operating settings, to the EUT with a regional operating area, which contains the current position of own station.
- b) Send an addressed DSC telecommand to the EUT with different regional operating settings than the previous command.
- c) Move the EUT out of the regional operating area defined by the previous addressed telecommand into an area without regional operating settings.

Required results

- a) Check, that the EUT uses the regional operating settings commanded to it in a).
- b) Check, that the EUT uses the regional operating settings commanded to it in b).
- c) Check, that the EUT reverts to default.

A.3.8 Invalid regional operating areas

Test for invalid regional operating areas (three regional operating areas with same corner)

Method of measurement

Set-up standard test environment and operate EUT in autonomous mode. Perform the following tests in the following order after completion of all other tests related to change of regional operating settings:

- a) Send three different valid regional operating settings with adjacent regional operating areas, their corners within eight miles of each other, to the EUT by DSC telecommand, Presentation Interface input and manual input via MKD. The current own position of the EUT shall be within the regional operating area of the third regional operating setting.
- b) Move current own position of the EUT consecutively to the regional operating areas of the first two valid regional operating settings.

This test can be accomplished by either using a dedicated test input for simulated position information or a GNSS simulator.

Required test results

- a) Check, that the EUT uses the operating settings that were in use prior to receiving the third regional operating setting.
- b) Check, that the EUT consecutively uses the regional operating settings of the first two received regional operating areas.

A.4 DSC Receiver Tests (ITU-R M.1371 A3)

In the case of a time-shared DSC Receiver, the EUT will need to be placed into a test mode that enables continuous reception of the DSC signals. If the manufacturer declares that the receiver is identical to the TDMA receiver, then tests A.4.2 to A.4.7 may be waived at the discretion of the test house and this fact noted in the test report.

A.4.1 Maximum Sensitivity**Definition**

The maximum sensitivity of the receiver is the minimum level of the signal dBm at the nominal frequency of the receiver which when applied to the receiver input with a test modulation will produce a bit error rate of 10^{-2} .

Method of measurement

The wanted signal shall be standard test signal number 1. The EUT shall provide a logic level test output from its internal DSC demodulator to measure bit error rate. Alternatively, packet error rate may be measured and interpreted back into bit error rate by calculation.

Required result

The maximum usable sensitivity shall not exceed -107 dBm under normal test conditions, and -101 dBm under extreme test conditions. The test shall be repeated at the nominal carrier frequency (156,525 MHz) +/- 1,5 kHz.

A.4.2 Error Behaviour at High Input Levels**Definition**

The dynamic range of the equipment is the range from the minimum to the maximum level of a radio frequency input signal at which the bit error rate in the output of the receiver does not exceed a specified value.

Method of measurement

A test signal, in accordance with standard test signal number 1, shall be applied to the receiver input. The level of the test signal shall be -7 dBm.

Required result

The BER shall not exceed 10^{-2} .

A.4.3 Co-Channel Rejection**Definition**

The co-channel rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal, both signals being at nominal frequency of the receiver.

Method of measurement

The wanted signal shall be standard test signal number 1. The level of the wanted signal shall be -104 dBm.

The unwanted signal shall be modulated by 400 Hz with a deviation of ± 3 kHz. The input level of the unwanted signal shall be -114 dBm.

Both input signals shall be at the nominal frequency of the receiver under test and the measurement shall be repeated for displacements of the unwanted signal of up to ± 3 kHz.

Required result

The BER shall not exceed 10^{-2} .

A.4.4 Adjacent Channel selectivity**Definition**

The adjacent channel selectivity characterises the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal that differs in frequency from the wanted signal by 25 kHz.

Method of measurement

The wanted signal shall be standard test signal number 1. The level of the wanted signal shall be -104 dBm.

The unwanted signal shall be modulated by 400 Hz with a deviation of ± 3 kHz. The input level of the unwanted signal shall be -34 dBm. The unwanted signal shall be tuned to the centre frequency of the upper adjacent channels.

The measurement shall be repeated with the unwanted signal tuned to the centre frequency of the lower adjacent channel.

Required result

The adjacent channel selectivity for a BER not exceeding 10^{-2} shall not be less than 70dB under normal test conditions and not less than 60dB under extreme test conditions.

A.4.5 Spurious Response Rejection**Definition**

The spurious response characterises the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal with frequencies outside the band of the receiver.

Method of measurement

The wanted signal shall be standard test signal number 1. The level of the wanted signal shall be -104 dBm.

The unwanted signal shall be unmodulated. The frequency range shall be calculated in the same manner as in 12.2.5. The level of the unwanted signal shall be -34 dBm.

Required result

The BER shall not exceed 10^{-2} .

A.4.6 Inter-modulation response Rejection**Definition**

The inter-modulation response ratio characterises the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

Method of measurement

The wanted signal represented by signal generator A shall be at the nominal frequency of the receiver and shall be standard test signal number 1. The level of the wanted signal shall be -104 dBm.

The unwanted signal from signal generator B shall be unmodulated and adjusted to a frequency 50 kHz above the nominal frequency of the receiver. The second unwanted signal from signal generator C shall be modulated by 400 Hz with a deviation of ± 3 kHz and adjusted to a frequency 100 kHz above the nominal frequency of the receiver. The input level of each

unwanted signal shall be -39 dBm. The test shall be repeated with the frequency of the unwanted signals below the nominal frequency of the receiver.

Required result

The BER shall not exceed 10^{-2} (for an inter-modulation response rejection ratio of 65dB).

A.4.7 Blocking or Desensitisation**Definition**

The blocking immunity characterises the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal with frequencies outside the band of the receiver.

Method of measurement

The wanted signal shall be standard test signal number 1. The level of the wanted signal shall be -104 dBm.

The unwanted signal shall be unmodulated. The frequency shall be varied between -10 MHz and -1 MHz and also between +1 MHz and +10 MHz relative to the nominal frequency of the wanted signal. The level of the unwanted signal shall be -20 dBm.

Required result

The BER shall not exceed 10^{-2} .

Annex B (informative)

Channel management regions

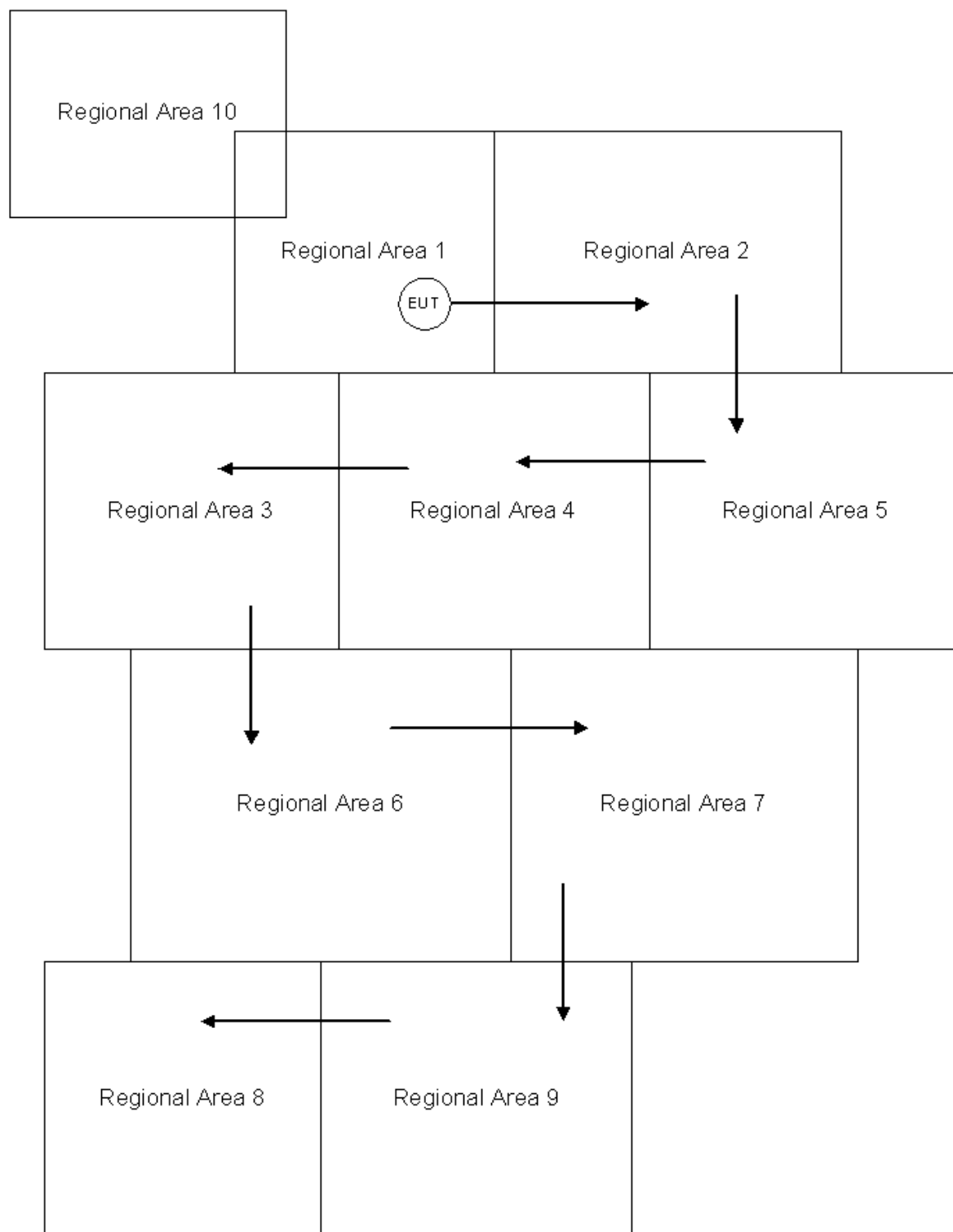


Figure B.1 Channel management regions used for Test 13.3.1